MBTA Assessment Formula

An Evaluation and Recommendations

Future MBTA Service and Funding Alternatives, Volume IV

A report prepared for
the MBTA Advisory Board

MBTA ASSESSMENT FORMULA
An Evaluation and Recommendations

Prepared for
MBTA Advisory Board

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Preface

This monograph, the fourth in the four volume series Future MBTA Service and Funding Alternatives, was prepared for the MBTA Advisory Board by Georges G. Korsun, an independent consultant. Final preparation of the material was completed by Maryann Foley of the Advisory Board staff.

The study series was funded by a grant from the Urban Mass Transportation Administration of the U.S. Department of Transportation. The alternatives presented in the four volumes will be reviewed by a public panel whose purpose will be to recommend changes in how the T is financed and/or how communities are assessed for T services.

The four volumes in the series were prepared during 1986-1988 under the direction of Advisory Board staff and a review committee of Advisory Board members. Reviewers Henry Hersey and Michael Burke completed their tenure as designees before the study was finished and in early 1988, Maryann Foley followed Carol Wallace as Project Manager.

Cover Design

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EXECUTIVE SUMMARY

Our evaluation of the MBTA assessment process leads us to the following summary conclusions and recommendations:

Conclusions

- The formula is in principle well designed since it recognizes that there are both regional and community specific benefits to the transit system and it tries to account for both in allocating deficits.

- Its implementation, however, blurs this distinction and leads to confusion over its purpose. The weights chosen to reflect regional and community benefits date to the MBTA's formation and have not been adjusted to reflect changes to the system.

- Since the formula's inception in 1964 there have been a number of politically motivated amendments which have introduced significant distortions in the deficit allocation process.

- The current formula is not stable; formula elements captured by conceptually similar but independently collected measures yield widely different distributions of assessments. This means extreme care must be used in the selection of the input variables.

- Input data which presently drive the portions of local and express assessments concerned with service usage are outdated, misleading, and generally poor proxies for actual service utilization. This is a major source of inequity which could be easily eliminated without generating much controversy.

- The line components within the express (e.g. commuter rail, red line, etc.) and local (e.g. express buses) service categories exhibit different cost/revenue patterns and serve different populations. This suggests that the deficits they create be assessed separately.

Recommendations

- The general subsidy (non-earmarked funds from the state and federal government) should be allocated to reflect the relative productivity of each type of service in generating public or regional benefits.

- The determination of this ratio of relative public benefits generation is largely a political decision which must be made in a public setting informed by the best available empirical evidence.

- The most appropriate forum for this debate is the Advisory Board itself since it is charged with making policy recommendations to the T, it is representative of all communities in the district, and it has the support staff to provide policy options.

- Once an appropriate ratio is selected, it is used to allocate the general subsidy between express and local services. Any remaining deficits are allocated strictly by measures of direct benefits received by the individual communities.

- Measures of direct benefit to the communities should include ridership data for express and share of losses sustained locally for local service. They may be expanded to include measures of service availability although accurate proxies for this variable will be difficult to obtain.

● It is imperative that accurate ridership data be collected to replace the misleading boarding counts and local route revenue distribution currently in use. This implies that some ridership surveys and improvements to the method of allocating revenues on bus routes must be undertaken. It also means that a consistent and sound method of allocating pass revenues must be devised.

● It is recommended that express service be divided into its components of commuter rail and rapid transit and each be treated as a separate service category. Express bus service which is currently contained in local service should also be treated separately. It might further be advisable to divide rapid transit into its component lines.

● The express general subsidy should be divided among line components in proportion to the revenues generated by each line. This provides the proper incentive structure to stimulate ridership and offsets the disincentives which are sometimes presumed to result from the use of ridership measures to allocate remaining deficits.

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Chapter I

INTRODUCTION

The delivery of public transit services in the greater Boston area is the responsibility of the Massachusetts Bay Transportation Authority, a consortium of 78 independent municipalities. In fulfilling its charge, this authority must continually balance the diverse needs of the member communities to determine both overall service levels and the allocation of its resources among the members. Since 1964 and the expansion of the original district of inner 14 cities to 78 (Maynard elected to join in 1966 but has since opted out), this task has become much more complicated as the range of public transit requirements has broadened.

The past 22 years have witnessed the formation of numerous jurisdictional alliances of varying stability to lobby for self-serving exemptions and amendments to any number of system characteristics. While virtually all facets of MBTA operations, like those of other major transit systems, have generated controversy, it is no hyperbole to declare that the peak of this clamor is reserved for the issue of assessments.

The problem, of course, is that fares and associated revenues do not cover costs, even after the sizable contributions from the state and federal government are accounted for. Route selection, station sitings, quality of service, etc., are all emotional issues which readily engender debates but nothing quite to the scale of those dealing with deficits produced by the assessment process. The latter, after all, tap directly into municipal coffers.

In as much as these shortfalls will most likely always exist, the task of the assessment formula is to distribute the deficits equitably. The primary charge of this study is to evaluate the formula's effectiveness in accomplishing this goal; this

effort is one portion of a larger, UMTA-funded research project on future funding alternatives.

A. STUDY OBJECTIVES

The fundamental objectives of this study are to gauge the success of the formula in achieving its stated goals and to make recommendations to redress shortcomings made evident by the evaluation. Specifically, we:

1. Review the historical background of the formula and analyze its objectives.

2. Review the formula components and analyze their role in meeting these overall objectives, the kind of incentive structure they provide for selecting service levels, and their relative importance in the final community assessment figures.

3. Consider how the application of the formula components further impacts the ability of the formula to achieve its goals. Consider the significance of formula constants and the quality of the input data.

4. Provide the theoretical context for evaluating the success of the formula at meeting its objectives and for constructing guidelines for corrective amendments.

5. Review the major concerns raised by the transportation community regarding the formula and attempt to validate them empirically.

6. Provide recommendations for changes in the formula which take account of theoretical guidelines, restructured community incentives, data requirements, political feasibility, and administrative and implementation costs.

7. Consider the economic and equity aspects of the recommended changes for the 78 member jurisdictions.

B. STUDY OUTLINE

The study proceeds as follows. Chapter II treats the current assessment formula and financial climate for the MBTA. It begins with a review of the history of the formula and funding trends. It describes the deficit allocation method and relates the "official" MBTA formula objectives and definition. An analysis of formula components and summary results of a sensitivity analysis follow.

Chapter III presents a brief review of the economic theory of transit subsidies, including topics such as public goods and externalities and efficiency and equity. A more detailed examination of the equity aspects of the current formula is presented in Chapter IV, including both anecdotal and empirical evidence.

Finally, Chapter V reports on a series of recommendations for making the formula more equitable. It consists of a delineation of general principles as well as specific changes and their associated benefits and drawbacks. Assessment calculations for CY 1985 based on the new formulas are presented to provide some indication of the impact of the recommendations.

Chapter II

THE CURRENT MBTA ASSESSMENT FORMULA

We begin this chapter with a brief history of the formula and a description of some general trends in transit financing for the MBTA District. This is followed by a formal set of objectives and definition and explanation of the current formula cited from the MBTA Annual Report, 1984. We then review each of the formula elements to determine their purpose and how well they fulfill these aims. Finally, we report a summary of the findings of a sensitivity analysis previously conducted for the MBTA Advisory Board.

A. A BRIEF HISTORY OF THE FORMULA

In 1964, Chapter 161A of the General Laws of the Commonwealth of Massachusetts set out a formula for distributing the transit system deficits among the 79 cities and towns of the newly expanded MBTA District. What had been a long lived organization of 14 cities with reasonably similar transit needs became a recalcitrant association of 79 with dissimilar needs. No small wonder, then, that from its inception the formula has chronicled the triumph of political compromise over sound reasoning.

The formula began with some concessions to the outer 65 and the unfulfilled promise that express service would break even (or close to it); that is, a combination of revenues from fares, advertising, etc. and federal and state grants would closely approximate costs. Among the former were the choice of weights for the formula and the separate determination of local assessments for the 14 and 65 groups. The latter meant that outer communities' assessments would remain small since they enjoyed very little local service.

In 1969, the first two alterations were effected. The first of these changed the definition of commuters (at the urging of Cambridge) from a person working in Boston and Cambridge to a person whose place of work is in a municipality other than the municipality of residence. The second fixed Boston's share of commuters at a floor of 30% (at the urging of everyone but Boston, presumably).

Three years later, the paradox of a secessionist threat by some of the outer municipalities and the largess of the Nixon administration towards mass transit was cleverly resolved by another amendment which declared post-July 1973 express stations non-existent for boarding count purposes. This way, express system expansion would encounter little resistance since the chosen municipalities could reap all the tremendous benefits of new rapid transit or commuter rail stations while spreading the costs among all district members.

A critical factor in keeping the district together in that period of heavy dissension was the introduction in 1973 of a new partnership arrangement with the state whereby some 50% of the deficit would be covered by state general subsidies. (See the next section for a recounting of funding trends).

In 1981, a coalition of outer communities headed by Pembroke prevailed on the legislature to pass a bill granting 100% assessment rebates to jurisdictions defined as "non-served", meaning they had no local service (or only closed door service) and no express stations situated within their borders (see Appendix B). Through this legislative action, these communities essentially declared themselves out of the MBTA District when it came to deficit sharing but very much in the district when it came to policy recommendations or actual use of the system.

The last chapter in this short history came to a close on April of 1984 when the town of Maynard was allowed to withdraw from the MBTA pursuant to a Supreme Judicial Court decision. In principle, this was permitted only because Maynard had volun-

tarily enlisted by special action in 1966 but the extent to which this precedent may be used in the future is not completely clear.

B. TRENDS IN DEFICIT FUNDING

A primary contributing factor to the expansion of the district was the notion that assessments for the outer 64 communities would remain small. This assertion was based on the erroneous premise that express service would cover the majority of its costs. This of course has turned out to be absolutely untrue and assessment shares for the outer 64 have been substantial, though generally lower on a per capita basis than inner 14 shares. Table 2.1 reports the relative contributions of the 14/64 communities towards the express and local deficits.

Table 2.1
Percentage Shares of 14/64 Assessments

	Local		Express	
	14	64	14	64
1978	84.1	15.9	65.6	34.4
1979	84.8	15.1	65.7	34.3
1980	84.2	15.8	65.8	34.2
1981	83.7	16.3	65.9	34.1
1982	84.2	15.8	65.9	34.1
1983	83.7	16.3	65.9	34.1
1984	83.7	16.3	65.9	34.1
1985	84.1	15.9	64.0	36.0

Source: MBTA Assessment Schedules, 1978-1985.

These shares have remained remarkably stable in this period with the outer 64 communities' contributions towards express deficits pegged as an unexpectedly high 34%.

The district members have not entirely borne the brunt of rising costs and disappointing revenues, however, because federal and state contributions have risen. Table 2.2 presents the rel-

ative contributions of the four funding sources of the system: revenues (fares, advertising, etc.), state and federal grants, and local assessments.

Table 2.2
Funding Sources by Service Category

	CY	1980	1981	1982	1983	1984	1985
Total							
	Income	25.2	29.9	29.7	28.5	26.7	26.3
	Federal	8.6	7.5	6.5	5.6	6.3	4.5
	State	40.8	38.9	38.7	42.2	44.6	48.1
	Local	25.4	23.7	25.1	23.7	22.4	21.1
Express							
	Income	25.5	32.2	30.2	27.3	25.5	25.7
	Federal	9.2	7.9	7.2	6.1	6.6	4.8
	State	41.9	39.6	40.7	45.3	47.7	50.7
	Local	23.3	20.2	21.9	21.3	20.2	18.7
Local							
	Income	25.5	27.1	30.0	31.6	29.6	28.2
	Federal	7.7	7.1	5.5	4.9	5.9	4.1
	State	37.6	36.6	34.0	35.8	38.5	42.6
	Local	29.2	29.2	30.5	27.7	26.0	25.1

Source: MBTA Statement of Net Cost of Service, 1980-1985.

Prior to CY 1973 service, state assistance was limited to debt retirement and reimbursement for commuter rail service to communities outside the district. After CY 1973, the state began contributing funds toward the deficit on a 50-50 basis with the cities; these appropriations began to take effect in the FY 1975 budgets. Since the passage of Proposition 2 1/2 in 1980[1], the communities' total contributions have been capped and the state's share has increased as system costs have exceeded a 2 1/2 percent growth rate. This has led, naturally, to a decline in the proportion of the burden borne by the local jurisdictions.

[1] Proposition 2 1/2 was passed by referendum in November of 1980, amended in December of 1980, and put in effect in 1981. Because of the lag between CY assessments and FY assessments, it did not actually cap MBTA District spending until FY 1983.

C. MBTA ASSESSMENT OBJECTIVES

This statement of objectives is taken from the MBTA Annual Report, 1984.

"The MBTA assessment procedures can be summed up by pointing out two objectives in the formulas. The first objective is to recognize that the cities and towns of the MBTA district comprise one regional transportation district, that all municipalities benefit by the system, and therefore, all must share some of the deficit. The second objective is to assess properly that portion of the assessment to those cities and towns that are receiving a greater degree of service."

D. MBTA ASSESSMENT PROCEDURES

These procedures are also quoted from the MBTA Annual Report, 1984.

"The assessment formulas for sharing the deficit were originally spelled out in state legislation passed in 1964 when the old MTA district, serving 14 cities and towns, was enlarged to the present regional transportation district and renamed the MBTA. The formulas have been amended by the legislature from time to time in an effort to make the assessment more fair and equitable.

"The legislation defines two basic types of MBTA service, 'express service' and 'local service'. Express service refers to rapid transit service [or commuter railroad] on controlled rights-of-way, while local service refers to MBTA buses, trackless trolleys and streetcars [or subcontracted services] in local streets. The net cost of providing each of these types of service is calculated separately and allocated by a different formula.

1. Express Service.

"Legislation has divided the assessment for the cost of express service into two parts, a 75% portion, and a 25% portion, each distributed in a different fashion.

"The 75% portion of the net cost of express service is shared by all 78 cities and towns in the MBTA, based on the number of 'commuters' living in each municipality. The number of commuters in each city and town was determined from the 1970 Federal Census data[2] and included all people who traveled outside their town to their place of work, whether they used public transportation or not. In the case of the City of Boston, the number of commuters was established so that Boston would be responsible for not less than 30% of the 75% portion.

"The remaining 25% of the net cost of service is shared only by those cities and towns that have one or more express service stations. This part of the assessment is proportional to the number of passengers boarding the rapid transit and railroad lines at stations in each community. By law, counts are taken to determine the number of passengers boarding at each station and within each town, no less frequently than every two years. However, in 1973, the legislature amended the assessment procedure to exclude from the boarding counts passengers boarding at new rapid transit stations opened after July, 1973[3]. This amendment means that a new station in a community will not result in an increase in its assessment for the 25% portion of express service costs.

2. Local Service.

"Local service refers to buses, trackless trolleys, and streetcars operating on local streets. As in express service,

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[2] Starting with CY 1985 assessments, budgeted in FY 1987, 1980 Census Data are used.

[3] See Appendix B for a list of communities with exempt stations.

the formula for assigning the local service deficit is divided into two parts, each of 50% portions. Half of the local service deficit is allocated on the basis of population as determined by the most recent Federal Census (1980); on the weight of 14 cities and towns and 64 cities and towns independently. The other 50% is shared by those cities and towns that have such a service and is based on the proportion of losses incurred by each city or town.

Table 2.3
Summary of MBTA Assessment Procedure

Type of Service	Portion of Deficit	Who Pays	Basis of Assessment
Express	75%	All communities	# of commuters
	25%	Comm. with rapid transit & R.R.	Boarding counts
Local	50%	64 outer comm. 14 inner comm.	Population
	50%	Comm. with bus service	Share of losses incurred locally

Source: MBTA Annual Report, 1984.

"To determine the operating loss incurred in each community, costs are first identified with a mode of service - bus, trackless trolley and streetcar. All direct costs are identified directly with the appropriate mode, and indirect costs are allocated to modes largely based upon the direct charges to each mode each month. Costs by mode are then allocated to specific routes by means of one of six bases depending on the type of expense involved. Direct costs of operations and maintenance of each rating station (depot) are allocated only to routes emanating from the rating station. For example, costs of operating and maintaining

routes from the Quincy Garage are allocated only to the routes in the Quincy Rating Station.

"Farebox revenue is sampled on each route four times yearly, and the difference between operating cost and revenue determines the yearly profit or loss for each route. This profit or loss is allocated to each city or town on the route. If a town elects to have no local service, buses then make no stops in that town, and the profit or loss from routes passing through that town is distributed among the other towns on the route. For all cities or towns with local MBTA service, the losses and profits from the routes in the community are totalled. Half of the MBTA's local service assessment is then based on the percentage of local service operating losses incurred in each municipality."

E. CALCULATION OF NET ASSESSABLE COSTS

A critical element in the determination of community assessments is the net assessable costs for each type of service; it is this dollar amount which drives the formula described above. Because of this and because a change in the way this figure is calculated is a fundamental recommendation of this report, we present now a detailed explanation of how these are currently derived. For the purposes of this example we present, as Illustration 2.1, actual MBTA figures for CY 1985[1]. The steps involved are:

1) Distribute total costs between express and local service; this is done through the MBTA Modal Cost Allocation Model (MCA).

2) Subtract total income which includes fares, advertising, etc.; this is also accomplished by the MCA and yields line (3).

3) From line 3, subtract the categorical grants or subsidies to each service (line 4); this yields line (5).

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[1] We omit here and throughout the study consideration of the MTA debt since it is an artifact of the old T District and should be independent of the MBTA assessment procedures.

ACTUAL

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Allocation of State Aid for Calendar Year 1985

		Total	Balance Express	MTA Debt	Total Express	Total Local
Total Estimated Current Expenses (Excluding Amort. & Int. & Depr.)	(1)	$454,530,625.56	$281,519,875.02	$5,533,744.24	$287,053,619.26	$167,477,006.30
Less: Total Income	(2)	119,767,564.22	72,454,745.39	-	72,454,745.39	47,312,818.83
Net Cost of Service In Excess of Income (Prior to Federal Operating Grants & Other Assistance)	(3)	334,763,061.34	209,065,129.63	5,533,744.24	214,598,873.87	120,164,187.47
Less: State & Federal Aid (Not Including Sec. 9 Systemwide & Add'l State Aid)						
Chap. 161A (Sec. 28) MTA		3,000,000.00	-	3,000,000.00	3,000,000.00	-
Chap. 161A (Sec. 28) MBTA		58,994,100.03	52,504,749.02	-	52,504,749.02	6,489,351.01
Chap. 234 Acts of 1984 - (RR)		5,055,758.00	5,055,758.00	-	5,055,758.00	-
Chap. 140 Acts of 1985 - (RR)		4,142,000.00	4,142,000.00	-	4,142,000.00	-
Section 5, Federal - (RR)		4,937,715.00	4,937,715.00	-	4,937,715.00	-
Total Assistance (Excluding Sec. 9 Federal Systemwide and Add'l State Aid)	(4)	76,129,573.03	66,640,222.02	3,000,000.00	69,640,222.02	6,489,351.01
Subtotal	(5)	$258,633,488.31	$142,424,907.61	$2,533,744.24	$144,958,651.85	$113,674,836.46
		(100.0000%)	(55.0682%)	(0.9797%)	(56.0479%)	(43.9521%)
Less: Federal Sec. 9 - Systemwide		$ 15,482,944.00	$ 8,526,178.57	$ 151,686.40	$ 8,677,864.97	$ 6,805,079.03
Additional State Assist. (C. 206)		147,392,419.22	81,166,352.20	1,444,003.53	82,610,355.73	64,782,063.49
Total Federal & Additional State Assistance	(6)	162,875,363.22	89,692,530.77	1,595,689.93	91,288,220.70	71,587,142.52
Net Assessable Cost of Service T District	(7)	$ 95,758,125.09	$ 52,732,376.84	$ 938,054.31	$53,670,431.15	$42,087,693.94

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4) Allocate the general federal and state subsidy between local and express. Currently, this is done in proportion to the deficits (line 5) which remain after steps 1-4. These amounts are shown in line 6.

5) Subtract line 6 from line 5 to arrive at the express and local net assessable costs (NACs).

F. ANALYSIS OF FORMULA ELEMENTS

1. Express/Local Distinction.

From its inception, the assessment formula has judged local and express services to be so different as to warrant separate formulas. This seems to be rooted in the notion that local service provides fairly limited public benefits and thus deficits incurred by this service should be allocated differently than for express service, which, arguably, provides greater regional benefits.

Unfortunately, the controlled right-of-way stipulation which defines express service in the existing legislation means that express buses must be considered as local service even though they are much more similar in spirit to express service.

It is very difficult to get a sense of the magnitude of this problem since figures breaking out express bus service are not readily available. A special study by the MBTA Advisory Board for CY 1982 suggests that express bus service (comprising ten of 170 routes) accounted for about 7.3% of costs while generating 10% of revenues (all figures exclude school buses). The net cost per mile was slightly more than half that of regular local service, substantiating the notion that express buses are a hybrid service which requires special consideration.

2. 75/25 and 50/50 Splits.

These splits represent the degree of public or regional benefits and private benefits generated by each service category.

Private benefits here mean benefits captured primarily by a particular community rather than individuals; public benefits are those enjoyed by the entire MBTA district. (See chapter III for a more extensive discussion of these terms.)

It is clear from the assignment of weights in the formula that the original legislation implicitly recognized this dichotomy but there is some question as to whether the weights chosen are appropriate. It has been suggested that they accurately reflect a consensus which existed 23 years ago; nevertheless, it is perhaps time that these ratios be reconsidered given the development of the system since then.

3. Number of Commuters (Express Formula).

This measure includes all commuters from a community, irrespective of travel mode; including all travel modes is clearly appropriate given the intent of this portion of the formula. A major drawback of this measure, unfortunately, is that the input data have been seriously out of date. Even up until 1984, these data were drawn from the 1970 census and thus failed miserably to account for the significant outward population migration in the last decade and a half. Inner municipalities especially have been needlessly harmed by this failure to obtain and employ timely information.

An additional special distortion results from Boston's share having been fixed at a minimum of 30%; 1980 census counts put the number closer to 18 to 20%, depending on the measure used.

4. Boarding Counts (Express Formula).

Boarding counts taken at express stations have served as notoriously inaccurate proxies for ridership and direct benefits; this is because they do not account for trip origin. One need only briefly consider an express station located in community A and bordering another municipality (B) to understand the magnitude of the distortions introduced by this measure. Community A is assessed for all riders boarding at this station no matter

how many actually reside in B. This deficiency was in part responsible for the introduction of a new distortion intended to compensate express station communities: the exclusion from boarding counts of stations opened after July 1973.

5. Exclusion of New Stations.

The availability of federal funds for mass transit and the problem alluded to above led to an amendment to the assessment formula which omitted stations opened after July 1973 from boarding counts. The apparent objective of this omission was to lower resistance to a system expansion. Unfortunately, equity is not particularly well served by pretending that these stations do not exist and it is time to consider repealing this amendment.

It is ironic that it is precisely these new stations which have generated tremendous tax revenue increases for the communities which harbor them. These windfalls due to land value appreciation have occurred entirely because close access to express stations is a highly desirable commodity.

6. Population Counts (Local Formula).

This variable is intended to capture the regional benefits produced by the local portion of the system. It is subject to the same inaccuracies resulting from data collection lags as (3) above.

A special and unwarranted distortion is that the portion of local deficits resulting from local service is first divided among the inner 14 and outer 64 communities and then shares are calculated separately.

7. Share of Losses Sustained Locally.

This variable is included to measure the direct benefits derived from utilization of local service. In principle, it can accomplish this quite well; in practice, it has been suggested that it may have some shortcomings.

The allocation of costs is done on the basis of bus miles, bus hours, and the number of peak buses required on each route and is reasonably straightforward. The allocation of revenues is much more problematic since there is no simple linear relationship between fares and bus miles or bus hours. Although periodic passenger and revenue counts are taken for each route, it is impossible under current practices to calculate accurately route revenues within municipalities since the sites of passenger boardings are not accounted for. An unfortunate consequence of this is that a community which enjoys much higher ridership per mile does not get credit commensurate with the increased bus hours likely to result from the higher density. Furthermore, there is no consistent way to fairly distribute pass income.

8. Non-Served Communities.

Some 23 municipalities[5] currently enjoy a special legislative rebate of their entire assessments because they are designated as non-served communities. This essentially contradicts the notion that there are regional benefits to this transit system and sets a dangerous precedent for communities to escape their social and financial obligations.

The implications for efficient service provision are also severe. Suppose a community has no direct service and thus gets a rebate of its "regional benefit" assessment. Introducing a single new route means the jurisdiction must pick up its portion of the deficit for this route in addition to forfeiting the rebate. This obviously drives the marginal cost of service completely out of line and makes local service expansion more difficult even when otherwise justified.

While it is undoubtedly true that many non-served communities get little direct benefit from the system, 1980 census data suggest that there may be significant ridership originating in these communities, particularly of commuter rail (See Chapter V).

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[5] See Appendix B for a listing.

G. SUMMARY RESULTS OF A SENSITIVITY ANALYSIS

This section relates some of the findings of a study of CY 1983 data by Mark Diamond reported in a 1985 memo to the MBTA Advisory Board.

A sensitivity analysis attempts to measure the effect of a change in a variable on total assessments, holding all other variables constant. Hence it can be used to predict the impact of singular changes in the assessment determinants which may occur over time due to population shifts, boarding count changes, etc. The most important result of this type of analysis is an elasticity measure associated with each variable which yields the percentage change in assessment due to a one percent change in each input variable. There were no statistical significance tests of group means performed; nevertheless it is still useful to examine the implication of these findings for the question of equity.

1. Increases in Commuters.

As expected because of the formula weights and magnitude of the express deficit, outer 64 communities show much higher elasticities for this variable than the inner 14 (.749 and .371, respectively).

Since commuter shifts are expected to occur in the direction of the Rt. 128 communities and there is little express service there, these results indicate that those communities might bear a disproportionate share of future deficit burdens. This is because their share of commuters will increase by a greater margin than their rate of express service utilization.

2. Increases in Population.

Inner 14 communities exhibit higher elasticities for this variable (.316 vs. .152 for outer communities). Population shifts in the last decade and a half have trended to the outer

municipalities and it is expected that this will result in proportionately lower assessments for the inner 14 cities.

3. Increases in Boarding Counts.

Inner 14 communities again exhibit higher elasticities for this variable (.094 vs. .051) but the differences are small and may not be significant. Furthermore, there is a wide range of individual elasticities with Boston and Cambridge being significant outlyers (.268 and .251, respectively). Since boarding counts are very inaccurate proxies for actual ridership, these two cities will suffer disproportionately from increased utilization of express service.

4. Increases in Local Route Losses.

Once again inner 14 communities show higher elasticities for this variable (.259 vs. .079 for outer communities) but these differences appear substantial. Although this measure is in some respects flawed, it is suggested elsewhere (Chapter V) that it could be fairly easily improved. If that is accomplished, then they will reflect actual usage and introduce no further distortions in local assessments.

Chapter III

THE ECONOMIC THEORY OF TRANSIT SUBSIDIES

The proper design of a formula to assess member communities for any deficits incurred by a jointly consumed service requires an understanding of some basic concepts in economic theory, particularly in the field of public finance. This chapter sets out to provide brief expositions of the most relevant of these concepts, paying particular attention to their implications for the issue of equitable assessments.

A. SOME PRELIMINARY DEFINITIONS

1. Organization and Units of Analysis.

The MBTA district can be thought of as a voluntary association or economic club organized to manage the production, sale, and delivery of a commodity, e.g. transit service. From this perspective, member communities can be thought of as individuals representing their residents who are a collection of economic agents with similar preferences. We can then confer upon each community the norm characteristics of its citizens and consider benefits to the community as the simple summation of benefits to its constituents. Thus the appropriate unit of analysis for the remainder of this chapter is the community.

2. Public Goods and Externalities.

A commodity or service is a pure public good if it meets two criteria. The first is non-exhaustability, which means the consumption of a unit of the commodity does not preclude the consumption of that same unit by others (e.g. clean air as opposed to hamburgers). The second is non-excludability, which means that no one can be technically or economically prevented from

consuming the good once it is provided (e.g. national defense as opposed to cable television).

Public transit is only an impure public good since it meets the first criterion (except perhaps at peak hours) but not the second. As such, however, its analysis is further guided by the theory of public finance because a transit system creates positive externalities.

A positive externality is a desirable byproduct of some economic activity which accrues to parties other than those involved in the transaction. Since the parties paying for the service do not capture all the benefits, they will tend to underconsume the commodity; they do not take into account the positive externality they are generating by purchasing the good in question or are unwilling to pay for these "public" benefits. This means that in the presence of a positive externality, social benefits will always exceed private benefits and there will be under-supply of the good or service. When the service is one which requires very large amounts of initial investment and sizeable continuing operating costs, public transit being a prime example, there may not be enough private demand to permit the service to be provided at the socially desirable level, if at all. Hence there is a need for subsidies to guarantee some level of provision or to engender some additional social benefits.

It is important to note that the subsidy is intended only to equate private and social marginal benefits; it is not intended to increase the private benefits of the users of a public service.

3. Consumer Surplus.

When consumers enter a market to purchase some commodity they confront a single price for that product. If the value they place on the product is at least equal to the given price, they will purchase it; whenever the value to the consumer exceeds the market price, the difference between the two is the consumer surplus for that unit of the good.

A community's consumer surplus will depend on its demand for the service (indicated by its marginal valuation of it) and its price. Although all communities may face the same fare for a particular service, the subsidies to each service category vary; even with identical demand curves, the consumer surplus of each community will vary with the service mix it consumes.

An approximate measure of consumer surplus can be realized given enough information about the demand characteristics and incomes of the communities. For this study, this requires estimating 78 separate demand functions and the data requirements are prohibitive. Therefore we do not attempt to calculate consumer surplus but rather rely on the concept as a guiding principle.

4. Equity.

The question of equity can be addressed from two different perspectives, based on an ability to pay principle or a benefits received approach. The first leads to considerations of vertical equity but although a subsidized transit system assuredly has serious wealth redistribution effects, these are not the concern of this study.

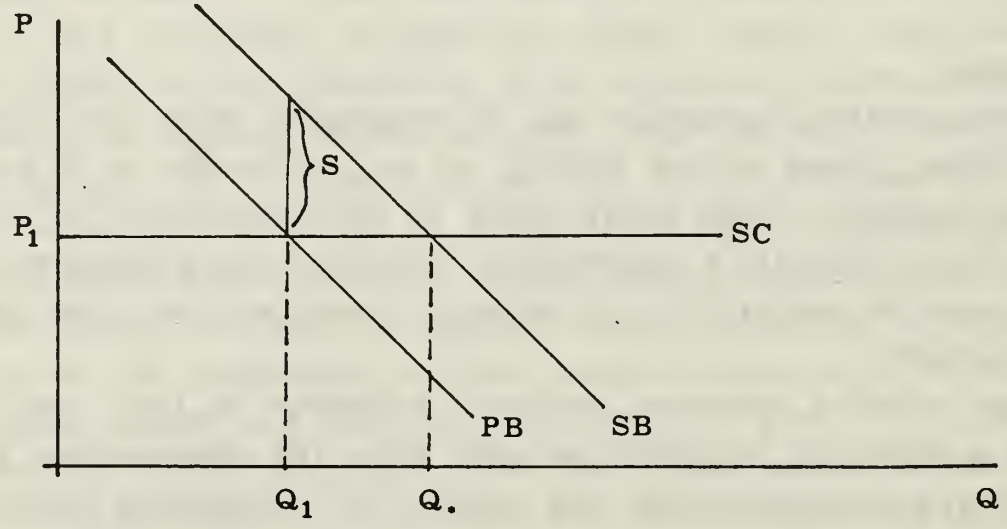
The benefits received principle attempts to link the financing of a publicly provided service with its consumption and is thus more appropriate for our task. Its successful application depends on the ability to measure accurately the distribution of benefits; deviations from this objective will result in distortions in equity.

B. THE ROLE OF SUBSIDIES

There are several basic reasons for defending state or federal subsidization of public transportation systems; the most relevant to this study arises from the fact that such a system generates positive externalities.

We have already seen that positive externalities imply that social benefits (SB) exceed private benefits (PB); this is equivalent to stating that society's demand for a service is greater than the private demand (see Diagram 3.1). The quantity demanded of the service and its price is determined by the intersection of demand and supply (which we assume horizontal in the relevant range). Without intervention, the equilibrium occurs at Q_1 with fare P_1; society, however, would prefer the quantity Q_*. One way to achieve this quantity is to provide a subsidy in the amount of S and shift the private demand curve to match society's.

Diagram 3.1



If there were not this divergence between the two demand functions, there would be no need for a subsidy. Conversely, state or federal subsidies as a source of funding are applicable only to the regional benefits which the system creates.

Unfortunately, current levels of subsidization do not cover all costs net of revenues so that the remaining deficit must be allocated to the communities in the system. An equitable as-

sessment formula will assign deficits to the participating communities in direct proportion to the private benefits received.

C. BENEFITS AND BENEFICIARIES

A complicating factor in the evaluation of benefits received is that the externalities are characterized by varying degrees of "publicness". Some accrue to all residents of the served region while others benefit only specific groups. A clear understanding of this distinction is a prerequisite to a careful design of any assessment formula.

The benefits generally attributable to regional transit systems as well as the gainers and losers from their presence can be divided into two broad classes. The first includes the reduced use of automobiles leading to less congestion (which benefits primarily the remaining drivers) and less pollution (which benefits all residents of the region unless there are gross distortions in service levels). If we assume that all remaining drivers are distributed in proportion to the general population, then both decreases in congestion and pollution are area wide benefits, the costs of which should be borne by all communities, though not necessarily equally.

Also in this group are the benefits derived from having some alternative form of transportation available when desired and a cluster of benefits, such as aesthetic qualities, reduced parking problems, etc. which lead to general improvements in the quality of life. These are assumed to be more or less completely capitalized in land prices; therefore a specific group, land owners, benefits directly while tenants are assumed to bear most of the burden. Again, however, if there are no gross distortions in service levels, all communities benefit from raised valuations and property tax receipts. If the concern is one of interjurisdictional equity, quality of life benefits may be treated similarly to congestion and pollution.

The second class of benefits includes those which have a differential impact on the communities which make up the system. The use of any type of transit service, for example, is also subsidized in that fares do not cover operating costs. This kind of a subsidy is effectively a direct income transfer, the benefits of which accrue only to the rider. A regional transit system will also introduce gross distortions in the pattern of land value appreciation. New rapid transit stations will create windfall profits for landowners in the immediate vicinity and result in increased property tax receipts only for those communities which harbor such stations. Likewise, the degree of access to some of the services varies with location; some communities obviously benefit more from express service than others.

In general, then, the first class of benefits may be considered public and therefore properly funded by general subsidies. The second class consists of private benefits which are subject to assessment on the basis of benefits received.

Chapter IV

EQUITY

The preceding chapter provided some theoretical guidelines for an evaluation of the equity aspects of public transit provision. We turn now to consideration of the assessment formula and its particular impact on the fair distribution of MBTA operating deficits.

At the heart of the controversy surrounding the assessment formula is the pervasive belief that the formula discriminates against certain communities. This is not in the least surprising since it is well understood by all concerned parties that, given any level of state and federal subsidy, the distribution of the remaining deficit among member jurisdictions is a zero-sum game, the rules of which are determined by the formula. Hence, controversy is one standard outcome typical of such shared public good situations where deficits have to be allocated among group members, particularly in the absence of unambiguous measures of benefits and costs.

These tensions exist largely because of the conflicting self-interests of member jurisdictions. In this particular instance, they are exacerbated by a number of external factors, including the growing costs of T service, possible limits on the state's contribution, and the communities' own capped taxing abilities. Since perceptions of the fairness of the assessment formula generally mirror the parochial interests of the affected communities, there is a lack of consensus over what constitutes inequalities. Any specific component of the formula will thus engender both positive and negative reactions.

We present in this chapter two different approaches to the fairness issue. The first relates the variously held perceptions of inequity through a largely anecdotal recounting of formula elements widely held to be in some measure unfair. These were

obtained through interviews conducted by the author and various Advisory Board staff members. The second is an empirical attempt to identify the extent of inequity imposed by the assessment formula and infer from these results which formula components might be most at fault.

A. PERCEPTION OF ASSESSMENT FORMULA INEQUITIES

During the past year, the Advisory Board staff has conducted a number of interviews with interested parties to solicit opinions on the specific issue of possible assessment formula biases. The following summary comments are intended to convey the range of opinions about the assessment process and are reported without attribution.

"Formula should weight boarding counts more and population less. Commuter counts are measure of benefits"..."Commuter counts are unfair; should be commuters who could use T where T service exists"..."Bedroom communities should pay more"..."Boston should pay more since T was designed for commuting into Boston" ..."Weston and Lincoln pay too little. The Ride is highly subsidized. This can't be justified considering the communities' wealth".

"Suburban communities without service should be brought in to help pay... opportunities are there to take rides into Boston" ..."Formula is biased against Boston; arbitrarily set at 30% but Boston should be 8 - 12%"..."Formula is too complex; state legislators do quick fixes"..."There should be a statewide tax to pay for transit"..."Formula doesn't work to Boston's advantage to expand service but transit is integral to infrastructure"..."The formula is a political concoction; not at all scientific".

"The definition of T district should be changed to eliminate 22 non-served communities"..."Would rather pay the assessment and get service than be out of system"..."It's a 30 minute drive to the nearest T station; if there's no rebate, the formula is

really unfair"..."The non-served communities should be taken out of the system. It's not fair for them to have a say in T operations since they don't pay anything"..."Communities have no veto power but can make it difficult for MBTA to build stations" ..."Definition of commuter should change to include only those who take MBTA".

"Current cry that Boston is paying more than fair share is not credible"..."MBTA commuter count not used because it would kill Boston; political decision"..."Local revenues pro-rated by mileage but costs based on time"..."Exempting new express stations helps Cambridge but is inequitable for other communities" ..."25% should be based on who uses T rather than boarding counts"..."Would like to see the state pick up total cost of express service and cities deal with local service. If local communities had to pay a higher portion, then a lot of unprofitable routes would be dropped"..."T's method of determining costs is slipshod"..."Express buses should be part of express assessment".

B. EMPIRICAL EVIDENCE

1. Objectives.

Given the emotional charge surrounding the issue of assessments, it seems worthwhile to search for some empirical evidence of the presence of inequities in the current formula and to quantify the magnitude of these inequities.

It must be emphasized that the exercise which follows is not an attempt to identify "delinquent" individual communities but rather one which seeks out patterns of inequities embodied in the formula as it stands. If such patterns are discovered, they may then logically be used to inform the development of recommendations for modifications to the formula.

2. Methodology.

Individual community assessments are calculated by the application of a deterministic formula which assigns specific weights to, and takes account of, four variables: number of commuters, population, boarding counts of express riders at designated stations, and net costs of local service.

The methodology proposed here is to develop another formula based on important community characteristics omitted from the current assessment formula which generates approximately the same total contribution by all communities. Subject to satisfying certain requirements about the appropriateness of the alternative formula, we can compare the assessments computed by the two formulas to see if there are significant differences between them.

The search for this alternative formula depends on regression analysis to identify both the community characteristics and the weights to be assigned to them. If a regression model can be found which explains a substantial proportion of the variance in current assessments, it may be accepted as the basis of the alternative formula. An analysis of the differences between the predicted values from the new model and the actual assessments can then be performed.

Specifically, the procedure used was to regress per capita assessments (to control for population) for FY 1980 on a subset of 1980 Census data. One model which was found to do an excellent job of explaining the variance was selected for subsequent analysis.[1] This model, consisting of three variables and a constant, was found to explain 94% of the variance in actual assessments with all three variables and the constant statistically significant at generally accepted levels. The independent variables selected were: population density (DENS), mean travel time for work trips for all modes of transportation (TTIME), and percentage of work trips taken via public transportation (%PUB).

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[1] Details of final model selection, summary statistics, and the data set used are reported in Appendix A.

These were selected from a large set of possible variables measuring community characteristics, system performance, and system utilization in accordance with statistical procedures outlined in Appendix A.

Estimation of the model yielded coefficients for the independent variables which were then applied as weights to derive the "fitted" values of per capita assessments (FPCASS) to be compared with the actual values. These differences were then computed as a percentage of actual assessments to yield relative measures of over or under-payment. The 78 member communities were then grouped along several dimensions such as inner 14 and outer 64, served and non-served, etc. and group means were calculated and compared.

C. GENERAL RESULTS

There is no unambiguous a priori hypothesis to be made about the direction of the effect of DENS; in fact, while the coefficient is negative and significant, its magnitude renders it rather trivial. For TTIME, to the extent that public transit generates any benefit to non-users we would expect its effect on FPCASS to be negative; paying more for public transit should lead to time savings when averaged over all modes of travel. The relationship between FPCASS and *PUB should clearly be positive; it turns out to be so and both significant and substantial.

The new formula resulting from the estimation of the alternative model is:

PCASS = 15.49 - .00078 DENS - .358 TTIME + 1.672 *PUB

and shows per capita assessments decreasing as density and travel time increase and increasing as the percentage of commuters using public transportation increases. The elasticities, (computed at the mean) are approximately -.130 for DENS, -.407 for TTIME, and +7.93 for *PUB. The overwhelming importance of *PUB in deriving fitted values for per capita assessment is perhaps the most dam-

ning evidence of inequity in the current formula. The variable %PUB is a direct measure of public transit usage which is collected independently of current formula variables intended to measure the same phenomenon. As it will be argued later, there is considerable reason to believe this measure is more accurate than those currently used.

The model has an R^2 of .937 and an F statistic of 366.41, indicating that we may reject with a high degree of confidence the null hypothesis that the coefficients for the selected variables are zero (in which case the alternative model would have to be rejected).

Table 4.1 reports PCASS (per capita assessments), FPCASS (the fitted per capita assessment values resulting from the alternative model), DIFF (PCASS-FPCASS),%DIFF (DIFF/PCASS), and $DIFF (the difference in the two multiplied by the community's population). We delete community names and randomly order the results because we wish only to point out the divergence between the two methods of calculating assessments and not to identify "free riding" communities.

Table 4.1
Comparison of Actual and Predicted Assessments

PCASS	FPCASS	DIFF	%DIFF	$DIFF
15.95	12.02	3.93	24.6	92,300
52.15	58.91	-6.76	-13.0	(644,377)
13.29	22.65	-9.36	-70.4	(170,184)
36.36	42.76	-6.40	-17.6	(162,758)
12.38	18.86	-6.48	-52.3	(46,488)
15.08	16.09	-1.01	-6.7	(7,030)
12.70	15.37	-2.67	-21.0	(30,326)
14.99	24.18	-9.19	-61.3	(186,915)
20.41	16.88	3.53	17.3	39,324
42.85	35.24	7.61	17.8	366,947
14.81	10.73	4.08	27.5	37,393
14.54	11.41	3.13	21.5	40,900
38.75	32.65	6.10	15.7	159,210
14.09	16.26	-2.17	-15.4	(81,711)
64.69	63.10	1.59	2.5	895,160
18.42	20.85	-2.43	-13.2	(88,299)

PCASS	FPCASS	DIFF	%DIFF	$DIFF
58.48	51.29	7.19	12.3	395,896
14.96	11.68	3.28	21.9	31,862
18.23	16.33	1.90	10.4	56,010
18.23	21.69	-3.46	-19.0	(24,559)
16.93	21.78	-4.85	-28.6	(380,584)
14.62	11.17	3.45	23.6	38,871
36.92	34.41	2.51	6.8	133,999
11.95	22.15	-10.20	-85.4	(55,325)
17.14	14.23	2.91	17.0	58,567
12.37	16.10	-3.73	-30.1	(60,773)
41.87	37.19	4.68	11.2	271,796
19.81	27.67	-7.86	-39.7	(236,232)
13.85	10.17	3.68	26.6	15,217
11.60	11.47	0.13	1.1	898
36.40	31.76	4.64	12.7	119,990
25.68	16.81	8.87	34.5	35,010
14.72	15.20	-0.48	-3.2	(14,086)
15.16	22.56	-7.40	-48.8	(206,467)
35.32	27.04	8.28	23.4	692,390
10.04	13.53	-3.49	-34.8	(22,207)
15.74	11.12	4.62	29.3	111,342
18.46	19.74	-1.28	-6.9	(32,381)
14.41	19.85	-5.44	-37.8	(25,584)
8.48	15.46	-6.98	-82.3	(82,455)
38.74	35.48	3.26	8.4	121,256
12.02	11.42	0.60	5.0	39,133
10.33	11.25	-0.91	-8.8	(19,091)
12.11	12.28	-0.16	-1.3	(1,666)
15.98	10.73	5.25	32.9	60,139
13.56	13.66	-0.10	-0.7	(904)
14.99	14.82	0.17	1.1	6,574
21.32	18.50	2.82	13.2	69,784
12.86	11.72	1.14	8.9	19,741
15.67	20.80	-5.13	-32.7	(69,773)
12.50	10.90	1.60	12.8	6,478
16.53	18.30	-1.77	-10.7	(52,588)
14.28	15.64	-1.36	-9.5	(79,152)
36.05	31.61	4.44	12.3	152,665
15.95	10.68	5.27	33.0	64,094
18.00	15.26	2.74	15.2	77,317
16.50	16.75	-0.25	-1.5	(5,670)
43.70	40.14	3.56	8.1	151,026
13.27	10.77	2.50	18.8	39,238
41.92	43.61	-1.69	-4.0	(130,759)
15.25	13.32	1.93	12.7	41,348
14.13	26.73	-12.60	-89.2	(342,833)
14.02	16.87	-2.85	-20.3	(11,106)
13.79	19.08	-5.29	-38.4	(59,084)
17.11	19.11	-2.00	-11.7	(26,424)

	PCASS	FPCASS	DIFF	%DIFF	$DIFF
	17.36	17.62	-0.27	-1.5	(14,734)
	14.76	9.87	4.89	33.1	224,823
	12.87	10.62	2.25	17.5	30,346
	27.24	39.84	-12.60	-46.3	(1,067,762)
	13.47	10.21	3.26	24.2	45,728
	19.52	19.49	0.03	0.1	392
	13.16	9.73	3.43	26.1	19,582
	17.15	16.38	0.77	4.5	19,169
	13.97	16.07	-2.10	-15.0	(39,604)
	13.26	10.86	2.40	18.1	41,930
	17.60	19.73	-2.13	-12.1	(44,093)
	21.46	42.66	-21.20	-98.8	(409,033)
	16.53	13.49	3.04	18.4	111,343
TOTAL					2,168
AVERAGE	20.77	20.83	-0.42	-5.2	28
STD DEV	11.65	11.59	5.29	30.4	230,393
MAXIMUM	64.69	63.10	8.87	34.5	895,160
MINIMUM	8.48	9.73	-21.20	-98.8	(1,067,762)

The exceptionally good fit of the alternative model is confirmed by the very small excess revenue generated by it. The surplus amounts to $2168 which represents only .002 of one percent of total assessments for FY 1980. What is striking, however, is that a model of "reasonable" community characteristics generates tremendous deviation from the original individual assessments. There is a maximum 98.8% underpayment by one community and a maximum 34.5% overpayment by another. Table 4.2 reports those communities (once again with names deleted) more than one standard deviation from the mean in either direction.

Table 4.2
Largest Deviations from Current Assessments

	%DIFF	$DIFF	%DIFF	$DIFF
SD>3	-98.8	(409,033)		
2<SD<3	-89.2	(342,833)		
	-85.4	(55,325)		
	-82.3	(82,455)		
	-70.4	(170,184)		
1<SD<2	-61.3	(186,915)	26.1	19,582
	-52.3	(46,488)	26.6	15,217
	-48.8	(206,467)	27.5	37,393
	-46.3	(1,067,762)	29.3	111,342
	-39.7	(236,232)	32.9	60,139
	-38.4	(59,084)	33.0	64,094
	-37.8	(25,584)	33.1	224,823
			34.5	35,010
TOTAL		($2,888,362)		$567,599

At the very least, this evidence suggests that the current assessment formula lacks robustness; any number of acceptable substitute measures will radically alter the distribution of burden sharing. The importance of this finding is the inescapable conclusion which follows from it; the equity issue cannot be resolved until a clear rationale for the selection of formula components is advanced and assurances exist that these components accurately reflect what they intend to measure.

D. GROUP RESULTS

Strictly speaking, the analysis of group differences requires that the effect of all relevant subgroups which are to be investigated be analyzed together. This presents an insurmountable difficulty in that the sample is relatively small (n=78) and some subgroups would lack a sufficient number of observations for statistical significance. As a compromise, we

present some pair-wise comparisons of group averages for a number of categories with the caveat that the results may mask hidden interactions between other variables not explicitly tested.

The measure of interest in this analysis is %DIFF since it incorporates both actual and predicted assessments. The hypothesis is that if two groups are found to have statistically significant differences in the means, the groupings should help describe which factors lead to over or under-payment.

Table 4.3 reports group means and other descriptive statistics; a brief discussion of each pair-wise comparison follows.

Table 4.3
Group Statistics

	TOTAL	NON-SRV	SRV	INNER	OUTER	STA	NO ST
AVERAGE	-5.2	4.2	-9.2	6.9	-7.9	-13.7	1.3
STD DEV	30.4	29.2	30.0	11.1	32.6	26.9	31.3
MAXIMUM	34.5	33.1	34.5	23.4	34.5	23.4	34.5
MINIMUM	-98.8	-82.3	-98.8	-17.6	-98.8	-89.2	-98.8
n	78	23	55	14	64	34	44
F stat		1.73		1.66		2.53	
Sign. level		.10		.10		.02	

1. Served/Non-served Communities.

Twenty-three member communities have their assessments rebated annually by special legislative action because it is alleged that these communities get no direct service from the system. As a group, these communities appear to overpay on average by 4.2% and the difference between this group mean and the served communities mean is significant at the .10 level. While this result gives some credence to the special status enjoyed by these communities it is clear that the total reimbursements currently in effect drastically overcorrect for any existing inequity.

2. Inner 14/Outer 64.

The inner 14 communities made up the original transit authority district; the distinction between this group and the rest of

the communities is now reflected only in the manner in which local service assessments are allocated. Nevertheless, it is interesting to note that the difference in group means, though only weakly significant at the .10 level, is sizeable. Inner communities appear to overpay by some 6.9% on average while outer communities seem to underpay by some 7.9% on average. One possible explanation for this rests with the differential treatment accorded the inner group in the assessment of local service costs. Another is that the current formula does not accurately reflect the population migration which has taken place in the last decade.

3. Express Stations/No Express Stations.

This grouping shows the most significant (at the .02 level) as well as the most surprising results of all groupings. Communities without pre 1973 express stations appear to be overpaying by an average of 2.2% while those with pre 1973 stations seem to be underpaying by an average of 14.9%. This result is confounded by the fact that some communities have express stations which are not counted and others have both pre and post 1973 stations; the census data on public transit ridership used in the fitted model makes no such distinction.

E. CONCLUSION

The primary finding of the foregoing analysis is that individual assessments are extremely sensitive to the input measures utilized. The use of boarding counts as a major driver of the assessment formula thus guarantees a sizeable distortion in the distribution of deficits which unfairly burdens communities with express stations. The group analyses indicate that the provision of assessment rebates to certain municipalities is also inequitable and that inner 14 communities have been harmed by the delayed adoption of 1980 census data.

Chapter V

RECOMMENDED CHANGES TO THE ASSESSMENT FORMULA

This chapter presents recommendations for changes to the current assessment formula as remedies to problem areas and inconsistencies identified in chapters II and IV. By and large, these amendments should be considered incremental changes to fine-tune a formula which appears, in principle, to be well intentioned and of reasonably sound basis. The chapter begins with a declaration of the general principles underlying all new formulas and proceeds with the presentation of some suggestions for accomplishing the stated objectives through a set of formulas representing increasing levels of complexity. A comparison of actual CY 1985 assessments and the assessment figures generated by these new formulas is provided, along with brief comments about their effect and a detailed accounting of the assumptions used throughout the simulations. The chapter concludes with an evaluation of the implications of the new formulas and a discussion of incentive effects embodied in the recommendations.

A. GENERAL PRINCIPLES

1. The Division of Public and Private Benefits.

All new formulas developed here share a primary objective: to make explicit the distinction between the public and private benefits of the system. This distinction needs to be recognized and embedded directly into the deficit allocation process since, as was made clear in Chapter III, state and federal subsidies are justifiable only to the extent that they compensate for the regional benefits which the system provides.

This explicit division of the formulas into public and private components is accomplished in a two step procedure which

makes the allocation of general subsidies a direct part of the process. The public component portion of the formula first controls this allocation of general subsidies among express and local service categories to determine net assessable costs (NAC) for the system by service category. The private component portion then allocates this remaining net assessable cost strictly on the basis of user benefits.

This split is also desirable on administrative grounds because the correct allocation of each segment depends on widely different types of input. A formula which clearly separates these two components facilitates long term adjustments as social and political preferences change or as better technical information becomes available.

2. The Communities' Share of the Deficit.

The sum of the contribution which the member jurisdictions may provide is limited by law to annual increases of two and a half percent. In the past, the Commonwealth of Massachusetts has always made up the shortfall through general subsidies to the system. Although there are obvious equity implications in this arrangement, these are more appropriately considered in another report of the larger study which addresses alternative financing methodologies.

For our purposes, we assume the Commonwealth's contribution to be fixed for any particular year and treat only the horizontal equity aspects of the distribution of the communities' contributions.

3. A Hierarchy of the New Formulas.

The principal rationale for increasing the level of complexity in an assessment formula is that different service categories generate different levels of public benefits and usage patterns and exhibit widely different cost/revenue ratios. Consequently, as we narrow the range of services within formula components, we are able to obtain more precise linkages between

service costs and deficits on the one hand and service utilization on the other.

The public benefit portion of the formula apportions the general subsidy between service categories. Increasing the level of complexity for this component implies the cumulative subdivision of service types into finer categories. We propose four such levels:

i) Level A: maintains the traditional service distinction of express and local services.

ii) Level B: divides express service into rapid transit and commuter rail.

iii) Level C: divides rapid transit service into its line components, i.e. red, blue, green, and orange.

iv) Level D: shifts express bus service from local to a separate category under express service. This distinction is relegated to level D because no analysis can be provided due to data unavailability; in reality it is at least as important as the distinction between rapid transit and commuter rail.

A fifth subdivision which splits commuter service into its component lines is also possible but omitted here. A lack of data makes it impossible to determine whether cost/benefit patterns vary enough among the different lines to make this step advisable.

The same test of cost/revenue and usage pattern should be applied to any new service being considered (such as the commuter boat) to determine if the service in question deserves its own category.

The private portion of the formula allocates remaining deficits strictly on the basis of usage. Increasing complexity for this component means that measures which capture private benefits to the communities other than direct ridership are included. We propose two different formulas:

i) Level 1: The first level measures of service are ridership counts (RC) for the express service (in contrast to the boarding counts which the current formula uses and which ignore

trip origin) and share of losses sustained locally (SLSL) for local service (as is currently done).

ii) Level 2: Second level formulas include a measure of service availability but the choice of proxy for this variable is very difficult, for reasons discussed in the next section. We suggest, for the purposes of the simulations only, that this characteristic be captured by the number of stations in each community (SC) for express service and route miles for local service (RM).

Given the categories and data constraints presented above, there are six possible combinations of assessment formulas which we investigate. These are summarized in Table B.1 (Appendix B).

4. Data Requirements.

4.1 Public Component: Calculation of NAC's.

a) A Change in the Allocation of General Subsidies.

Currently, general state and federal subsidies (those not earmarked for specific uses by legislation) are allocated in proportion to the deficits incurred by each type of service (see chapter II, section E).

We propose instead that there be a fundamental process which first determines the relative productivity of each service component in generating regional benefits and that this ratio be used to allocate the general subsidy among express and local services. The second part of the formula then distributes any remaining deficit strictly on the basis of measures of direct community benefit.

We venture no estimate here of what these proportions should be but rather strongly suggest that they be established following extensive public consideration informed by the best available empirical evidence. The distribution of the subsidy among the various services is critical to the equity issue and belongs in the realm of socio-political decisions rather than arbitrary formulations.

It seems that the most appropriate forum for these deliberations is the Advisory Board itself. Its composition accurately reflects the membership of the MBTA and the Advisory Board would thus be representative of the varied interests of the region. One of its most important functions is to make policy recommendations to the MBTA; what we are proposing clearly falls in this category. Furthermore, since the issue is one which combines political and technical considerations, it could draw on its support staff for the evaluation and recommendation of policy options. Periodic reviews of this ratio (every two or three years) should become a formal part of the Board's agenda.

Table 5.1 presents a simplified comparison of current and recommended NAC calculations using express as an example. Steps 1-5 are common to both methods.

Table 5.1
Comparison of Current and Recommended Subsidy Allocation

Step	Line Item	Basis
1	Express Expenses	MCA*
2	- Express Income	MCA*
3	Net Cost of Express Service	
4	- Express Categorical Grants	State & Fed. Legislation
5	Express Deficit	
Current 6	- General Subsidy to Express	Ratio of Express Deficit to System Deficit
	Express Net Assessable Cost	
Recommended 6	- General Subsidy to Express	Ratio of Express regional benefits to total regional benefits
	Express Net Assessable Cost	

*MCA: MBTA Modal Split Cost Allocation Model

b) The Distribution of Costs and Revenues.

As service categories are expanded (moving from level A to level C), weights must be attached to distribute system-wide costs and revenue figures. The MBTA currently uses an extensive

modal split allocation model (MCA) to perform this task. Since the methodology relies on a bottoms up aggregation, it is theoretically possible to expand service categories to the route level. The standard output of the MCA computes costs and revenues for the Orange, Blue, Red and Commuter Rail lines plus three Green line service categories and three Local service categories.

We take for our weights the proportion which result from the year end 1985 run of the MCA. These are listed in table 5.2 .

Table 5.2
Share Weights for Various Service Categories

Service Category	Expenses	Revenues
All Rapid Transit	74.70%	76.60%
Commuter Rail	25.30	23.30
Orange Line	33.08%	28.09%
Red Line	32.16	33.90
Blue Line	6.59	11.11
Green Line	28.17	26.90

Source: MBTA Modal Cost Allocation Model, Local Split, 1985.

c) Allocating the General Subsidy for Levels B and C.

Once the ratio for allocating the general subsidy among express and local services is obtained by the process just suggested, it remains to further distribute the express subsidy among its components. We recommend that the express general subsidy be divided in proportion to the revenues generated by each line component (see Table 5.2). This step is computationally very simple and has positive incentive effects which are discussed later but it requires that the MCA assignment of revenues be as accurate as possible. This depends largely on data collection and there is general agreement that this is technically feasible through various means such as magnetic striping on passes.

4.2 Private Component: Distribution of NAC's.

a) Ridership Measures (Express): There is no question that current boarding counts are a very poor proxy for ridership and impose an unfair burden on communities harboring express stations. We recommend that ridership surveys be undertaken at all stations (including stations opened after 1973) to determine trip origin so that communities without stations may be properly charged for their use of the service.

b) Ridership Measures (Local): Current measures aim to allocate deficit where they are incurred by distributing costs and revenues on the basis of route miles (for more detail, see formula definition, Chapter II). The MBTA MCA report performs acceptably in allocating costs. The revenue side is much more problematic for two reasons: 1) data collection is generally thought to be subject to inaccuracies, and 2) the allocation of revenues to jurisdictions on any single route is difficult to perform, particularly when revenues from passes are taken into account.

A number of proposals have been advanced within the MBTA for improving this system; most focus on the need to account for where on the route passengers actually board. We strongly urge that these be evaluated and the best adopted.

c) Service Availability (Express): This variable is particularly difficult to measure accurately since it depends in part on proximity to neighboring communities' express stations, parking availability near these stations, and the presence of bus routes which feed express stations. The simplest proxy for service availability is the number of stations located within a jurisdiction. This is simply a technical calculation but we recommend that, at minimum, some adjustment be made for stations which border jurisdictions so that they be assigned to both communities on a proportional basis.

d) Service Availability (Local): The best and simplest proxy for this variable would seem to be route miles. Once again this only requires a straightforward accounting of local routes and the data already exist.

Table 5.3 presents a comparison of current and recommended assessment formulas for a sample community (A) once net assessable costs have been derived.

Table 5.3
Comparison of Current and Recommended Assessment Formulas

EXPRESS

$$\text{Current Assessment} = \left[\text{NAC(Express)} \times .75 \times \frac{\#\text{ of comm. from A}}{\text{total \# of comm.}}\right] + \left[\text{NAC(Express)} \times .25 \times \frac{\text{boarding cts. in A}}{\text{total boarding cts.}}\right]$$

$$\text{Recom. Assessment} = \left[\text{NAC(Express)} \times \frac{\#\text{ of riders from A}}{\text{total \# of riders}}\right]$$

LOCAL

$$\text{Current Assessment} = \left[\text{NAC(Local)} \times .50 \times \frac{\text{population of A}}{\text{total population}}\right] + \left[\text{NAC(Local)} \times .50 \times \frac{\text{local deficits in A}}{\text{total deficits}}\right]$$

$$\text{Recom. Assessment} = \left[\text{NAC(Local)} \times \frac{\text{local deficits in A}}{\text{total deficits}}\right]$$

Table 5.4 summarizes the variables for the new formulas.

Table 5.4
Variable Definitions

Ridership Count	RC	% of total number of riders using service category who originate from a community
Share of Losses	SLSL	% of losses incurred by all local service attributable to a community
Number of Stations	SC	% of rapid transit or rail stations located or assigned to a community
Route Miles	RM	% of total route miles located within a community

5. Diminishing Returns to Information.

The rewards accruing from using more complex formulas, as measured by a more equitable distribution of the deficit burden, are not without costs, however. The informational requirements and associated expenses increase as the degree of precision rises and there is undoubtedly some point of diminishing return.

The primary expense, of course, lies with the ridership surveys that are being recommended. Although these tend to be quite costly, timely collection of such data would drastically reduce inequity in assessments and aid other MBTA functions such as service planning immeasurably.

Less expensive alternatives to ridership surveys exist and their cost-effectiveness should be investigated. For instance, license plate counts and analysis at express station parking lots provide an inexpensive and fast measure of the distribution of the trip origin of commuters. This in itself is not sufficient but coupling it with other measures may permit the use of less extensive surveys.

It may also be possible to lower costs by cycling surveys by rapid transit line over a two year period. This compromise may introduce important distortions in assessments however because significant changes in ridership patterns often result from trivial and apparently unrelated external changes (such as the opening of a new parking lot close by an express station).

B. BASIC ASSUMPTIONS AND CHARACTERISTICS

1. Assumptions Common to All Formulas.

The simulations which follow rely on a certain number of assumptions which we presently make explicit.

1) In as much as the aforementioned debate has not yet taken place, we adopt a distribution for the general subsidy which reflects the status quo but is revenue driven rather than cost

driven as is currently done. Calculation of a five year average yielded a ratio of 65% express and 35% local.

2) Since independent ridership data are not currently available, we use the 1980 census worktrip data for the express portion of the formula. This report provides counts of rapid transit and railroad ridership by community but its use requires us to invoke assumptions (3) and (4) below.

3) The rates reported in the 1980 census have been fairly stable in the five years since their collection so that no significant change in commuting patterns have taken place.

4) The ratio of express mode work trips to total trips is constant across communities. This latter assumption is tenuous at best so that the simulations which follow will tend to underreport usage for the larger communities which are closest to Boston. This bias is somewhat mitigated in second level formulas since a measure of service availability is included.

5) For the private portion of the second level formulas, we are required to make an assumption about the relative weights to be assigned to the two usage measures. No reliable empirical information exists and we adopt a ratio of 80/20 to emphasize the importance of actual ridership.

2. Interpretation of Simulation Results.

Before proceeding with the application of the new formulas to 1985 data we must point out exactly how the results of this exercise can be most appropriately employed. We have already enumerated a number of assumptions which were invoked because the recommended measures were, for various reasons, unavailable. The proxies which are in place either as formula constants or input variables are all suboptimal in some fashion. Therefore we suggest that the simulations which follow be used primarily for two purposes:

1) as demonstrations of a new process for deficit allocation which allows for increasing accuracy if deemed cost justified.

2) as indicators of general trends in burden shifting among communities when priorities and input variables change.

It would be a serious mistake to consider the reported changes in individual community assessments as exact reflections of the effect of the recommendations of this chapter.

3. Effects of the Subsidy Reallocations.

The specific effects of changing the method of subsidy allocation to reflect social benefits obviously depends on the ratio which will ultimately come out of the public debate being suggested. However, for the purposes of our simulation, we have adopted the status quo but shifted from an allocation based on deficits to one based on revenues. This essentially means a shift in ratios from 56/44 to 65/35 and results in a transfer in assessable costs of $15,139,257 from express to local. Table 5.5 provides greater detail.

Table 5.5
Changes in the Allocation of General Subsidies

	CY 1985 ACTUAL*		
	Express	Local	Total
Expenses	281,519,875	167,477,006	448,996,881
Income	72,454,745	47,312,819	119,767,564
Categorical Grants	66,640,222	6,489,351	73,129,573
General Subsidy	89,692,531	71,587,143	161,279,674
Net Assessable Costs	52,732,377	42,087,693	94,820,070

	CY 1985 PROPOSED		
	Express	Local	Total
Expenses	281,519,875	167,477,006	448,996,881
Income	72,454,745	47,312,819	119,767,564
Categorical Grants	66,640,222	6,489,351	73,129,573
General Subsidy	104,831,788	56,447,886	161,279,674
Net Assessable Costs	37,593,120	57,226,950	94,820,070

*Source: MBTA Allocation of State Aid for Calendar Year 1985, Office of the Treasurer.

The primary consequence is to shift a greater proportion of the deficit burden to communities which make greater use of local service. There are three reasons why this might be desirable:

1) Even in the absence of empirical evidence, it is probably safe to say that express service generates the bulk of regional benefits and should therefore receive the bulk of general subsidies.

2) With current usage measures, it is also probably safe to say that those which capture local service are more accurate than their express counterparts.

3) The provision of local service is much more flexible than express and thus potentially more responsive to individual community needs. A positive by-product of shifting the burden to local service is that additional incentives are provided for communities to adjust their individual service requirements to efficient levels in the area where they most easily can.

C. LEVEL A FORMULAS

1. Net Assessable Costs.

The NAC's to all communities are:

NAC(Express) = (Express)Costs - (Express)Revenues - .65 x subsidy

NAC(Local) = (Local)Costs - (Local)Revenues - .35 x subsidy

Actual calculated amounts were reported in Table 5.5 .

Assumptions. This is the basic new formula with no additional assumptions necessary.

2. Formula A1.

A1 Assessment = NAC(Express) x (RC) + NAC(Local) x (SLSL)

where RC is ridership count and SLSL is the share of losses sustained locally.

Results. Table 5.6 reports actual 1985 assessments and those calculated by formula A1, listed by communities. It also reports

the difference between the two amounts as well as the percentage change in assessment incurred as a result of moving from the current formula to A1.

Table 5.6
Comparison of 1985 Actual and A1 Computed Assessments

COMMUNITY	ACTUAL*	A1	DIFFERENCE	% DIFF
ARLINGTON	2,030,215	1,837,449	(192,766)	-9.5
ASHLAND	210,109	14,104	(196,005)	-93.3
BEDFORD	226,806	101,363	(125,443)	-55.3
BELMONT	1,041,989	996,567	(45,422)	-4.4
BEVERLY	627,466	457,616	(169,850)	-27.1
BOSTON	38,607,284	40,870,726	2,263,442	5.9
BRAINTREE	756,250	1,049,347	293,097	38.8
BROOKLINE	3,498,557	5,292,879	1,794,322	51.3
BURLINGTON	558,208	440,915	(117,293)	-21.0
CAMBRIDGE	4,834,190	6,400,913	1,566,723	32.4
CANTON	326,903	314,562	(12,341)	-3.8
CHELSEA	908,764	1,011,781	103,017	11.3
COHASSET	115,498	29,063	(86,435)	-74.8
CONCORD	252,749	136,766	(115,983)	-45.9
DANVERS	412,201	261,078	(151,123)	-36.7
DEDHAM	542,393	501,532	(40,861)	-7.5
DOVER	88,102	11,540	(76,562)	-86.9
DUXBURY	180,807	7,693	(173,114)	-95.7
EVERETT	1,378,042	1,695,822	317,780	23.1
FRAMINGHAM	940,159	120,952	(819,207)	-87.1
HAMILTON	130,296	75,221	(55,075)	-42.3
HANOVER	177,582	5,984	(171,598)	-96.6
HINGHAM	398,852	352,248	(46,604)	-11.7
HOLBROOK	249,455	198,792	(50,663)	-20.3
HULL	146,460	57,271	(89,189)	-60.9
LEXINGTON	614,147	251,095	(363,052)	-59.1
LINCOLN	137,726	80,777	(56,949)	-41.3
LYNN	1,264,759	1,621,870	357,111	28.2
LYNNFIELD	209,752	45,731	(164,021)	-78.2
MALDEN	2,105,125	2,941,883	836,758	39.7
MANCHESTER	82,642	88,043	5,401	6.5
MARBLEHEAD	378,114	280,332	(97,782)	-25.9
MARSHFIELD	348,461	2,564	(345,897)	-99.3
MEDFIELD	175,374	35,046	(140,328)	-80.0
MEDFORD	2,480,823	3,045,895	565,072	22.8
MELROSE	641,122	950,649	309,527	48.3
MIDDLETON	78,736	4,701	(74,035)	-94.0
MILLIS	131,622	20,515	(111,107)	-84.4
MILTON	937,859	1,039,782	101,923	10.9
NAHANT	105,818	110,114	4,296	4.1

COMMUNITY	ACTUAL*	A1	DIFFERENCE	% DIFF
NATICK	495,894	123,089	(372,805)	-75.2
NEEDHAM	486,023	111,830	(374,193)	-77.0
NEWTON	3,068,468	1,964,501	(1,103,967)	-36.0
NORFOLK	102,601	42,312	(60,289)	-58.8
NORTH READING	208,707	44,449	(164,258)	-78.7
NORWELL	173,961	5,556	(168,405)	-96.8
NORWOOD	586,037	544,072	(41,965)	-7.2
PEABODY	744,751	89,753	(654,998)	-87.9
PEMBROKE	244,763	0	(244,763)	-100.0
QUINCY	2,493,112	4,703,654	2,210,542	88.7
RANDOLPH	613,982	468,334	(145,648)	-23.7
READING	462,526	345,929	(116,597)	-25.2
REVERE	1,966,872	2,640,497	673,625	34.2
ROCKLAND	237,272	3,419	(233,853)	-98.6
SALEM	617,920	417,660	(200,260)	-32.4
SAUGUS	532,949	424,867	(108,082)	-20.3
SCITUATE	277,674	25,216	(252,458)	-90.9
SHARON	278,750	243,614	(35,136)	-12.6
SHERBORN	76,508	17,951	(58,557)	-76.5
SOMERVILLE	3,170,367	3,750,069	579,702	18.3
STONEHAM	369,588	117,533	(252,055)	-68.2
SUDBURY	240,299	22,652	(217,647)	-90.6
SWAMPSCOTT	321,174	300,168	(21,006)	-6.5
TOPSFIELD	99,998	4,701	(95,297)	-95.3
WAKEFIELD	498,390	502,049	3,659	0.7
WALPOLE	332,956	183,717	(149,239)	-44.8
WALTHAM	887,707	616,078	(271,629)	-30.6
WATERTOWN	1,361,303	1,194,082	(167,221)	-12.3
WAYLAND	236,822	7,266	(229,556)	-96.9
WELLESLEY	402,088	302,595	(99,493)	-24.7
WENHAM	58,778	29,918	(28,860)	-49.1
WESTON	193,049	55,561	(137,488)	-71.2
WESTWOOD	280,704	173,126	(107,578)	-38.3
WEYMOUTH	1,123,041	951,571	(171,470)	-15.3
WILMINGTON	289,198	63,682	(225,516)	-78.0
WINCHESTER	412,044	366,106	(45,938)	-11.1
WINTHROP	425,657	838,119	412,462	96.9
WOBURN	672,717	363,192	(309,525)	-46.0

* 1985 Actuals do not include MTA portion of assessment for inner 14 communities.

The large majority of communities (60) show a decline in assessments; the mean change for the entire region is a 34% decline with a standard deviation of 47.3 . The two outlyers,

Winthrop (+97%) and Quincy (+89%), are there for different reasons.

Winthrop's large increase comes about exclusively as a result of its express assessment. Since no stations are sited there, it escapes the usage portion of the current formula but census data show it with a ridership count which exceed 31 of the 38 communities with stations. Quincy's increase can be attributed to a combination of large bus ridership and an express ridership count which is approximately twice that measured by the boarding counts of the current formula.

The group known as the non-served communities all exhibit declines, ranging from -49% (Wenham) to -100% (Pembroke), providing further evidence that the legislatively mandated rebates accorded these communities are an overcorrection. This is true for all members of this group, except perhaps in the case of Pembroke, which shows no ridership in MBTA or Census Data.

Ten of the 14 inner communities show increases in total assessments with a mean change of 13.4% compared to a mean change of -44.5% for the outer 64. This may seem surprising since 1985 actual assessments are based on 1970 census figures and these communities by and large have experienced population declines; however, it must be noted that the new formulas are only indirectly driven by population figures (through ridership).

It appears that the primary explanation for this phenomenon rests in the general subsidy shift from express to local since these communities all enjoy relatively heavy bus utilization. A confounding factor for some of these jurisdictions showing the largest increase is that they harbor post-1973 express stations which are not included in current formula boarding counts. It is interesting to note that Boston's increase is relatively minor; this is because the city bears a disproportionate share of the burden (fixed at 30%) of the public benefit portion of the current formula. The elimination of this constant, an automatic by product of the shift to new formulas, almost completely offsets the changes affecting the other inner 13 communities.

3. Formula A2.

A2 Assessment = NAC(Express) x [.8 x RC + .2 x SC]
+ NAC(Local) x [.8 x SLSL + .2 x RM]

where SC is the station count and RM is route miles.

Results. Table 5.7 reports actual 1985 assessments and those calculated by formula A2, listed by communities.

Table 5.7
Comparison of 1985 Actual and A2 Assessments

COMMUNITY	ACTUAL*	A2	DIFF	%DIFF
ARLINGTON	2,030,215	1,795,327	(234,888)	-11.6
ASHLAND	210,109	11,283	(198,826)	-94.6
BEDFORD	226,806	114,627	(112,179)	-49.5
BELMONT	1,041,989	1,041,510	(479)	.0
BEVERLY	627,466	622,899	(4,567)	-0.7
BOSTON	38,607,284	39,623,863	1,016,579	2.6
BRAINTREE	756,250	1,126,796	370,546	49.0
BROOKLINE	3,498,557	4,966,456	1,467,899	42.0
BURLINGTON	558,208	442,971	(115,237)	-20.6
CAMBRIDGE	4,834,190	6,237,275	1,403,085	29.0
CANTON	326,903	346,822	19,919	6.1
CHELSEA	908,764	958,908	50,144	5.5
COHASSET	115,498	166,009	50,511	43.7
CONCORD	252,749	204,585	(48,164)	-19.1
DANVERS	412,201	244,449	(167,752)	-40.7
DEDHAM	542,393	507,554	(34,839)	-6.4
DOVER	88,102	9,232	(78,870)	-89.5
DUXBURY	180,807	6,154	(174,653)	-96.6
EVERETT	1,378,042	1,541,784	163,742	11.9
FRAMINGHAM	940,159	144,348	(795,811)	-84.6
HAMILTON	130,296	107,763	(22,533)	-17.3
HANOVER	177,582	4,787	(172,795)	-97.3
HINGHAM	398,852	433,502	34,650	8.7
HOLBROOK	249,455	241,562	(7,893)	-3.2
HULL	146,460	45,817	(100,643)	-68.7
LEXINGTON	614,147	290,249	(323,898)	-52.7
LINCOLN	137,726	112,208	(25,518)	-18.5
LYNN	1,264,759	1,690,828	426,069	33.7
LYNNFIELD	209,752	36,585	(173,167)	-82.6
MALDEN	2,105,125	2,757,849	652,724	31.0
MANCHESTER	82,642	118,021	35,379	42.8
MARBLEHEAD	378,114	268,002	(110,112)	-29.1
MARSHFIELD	348,461	2,051	(346,410)	-99.4
MEDFIELD	175,374	28,037	(147,337)	-84.0

COMMUNITY	ACTUAL*	A2	DIFF	%DIFF
MEDFORD	2,480,823	2,969,854	489,031	19.7
MELROSE	641,122	959,216	318,094	49.6
MIDDLETON	78,736	3,761	(74,975)	-95.2
MILLIS	131,622	16,412	(115,210)	-87.5
MILTON	937,859	1,131,837	193,978	20.7
NAHANT	105,818	101,033	(4,785)	-4.5
NATICK	495,894	193,644	(302,250)	-61.0
NEEDHAM	486,023	296,171	(189,852)	-39.1
NEWTON	3,068,468	2,628,347	(440,121)	-14.3
NORFOLK	102,601	81,436	(21,165)	-20.6
NORTH READING	208,707	35,559	(173,148)	-83.0
NORWELL	173,961	4,445	(169,516)	-97.4
NORWOOD	586,037	626,394	40,357	6.9
PEABODY	744,751	71,802	(672,949)	-90.4
PEMBROKE	244,763	0	(244,763)	-100.0
QUINCY	2,493,112	4,376,646	1,883,534	75.5
RANDOLPH	613,982	454,701	(159,281)	-25.9
READING	462,526	333,393	(129,133)	-27.9
REVERE	1,966,872	2,644,629	677,757	34.5
ROCKLAND	237,272	2,735	(234,537)	-98.8
SALEM	617,920	465,907	(152,013)	-24.6
SAUGUS	532,949	446,722	(86,227)	-16.2
SCITUATE	277,674	210,518	(67,156)	-24.2
SHARON	278,750	242,478	(36,272)	-13.0
SHERBORN	76,508	14,360	(62,148)	-81.2
SOMERVILLE	3,170,367	3,502,494	332,127	10.5
STONEHAM	369,588	94,027	(275,561)	-74.6
SUDBURY	240,299	18,121	(222,178)	-92.5
SWAMPSCOTT	321,174	338,564	17,390	5.4
TOPSFIELD	99,998	3,761	(96,237)	-96.2
WAKEFIELD	498,390	535,685	37,295	7.5
WALPOLE	332,956	251,902	(81,054)	-24.3
WALTHAM	887,707	758,905	(128,802)	-14.5
WATERTOWN	1,361,303	1,208,541	(152,762)	-11.2
WAYLAND	236,822	5,813	(231,009)	-97.5
WELLESLEY	402,088	384,835	(17,253)	-4.3
WENHAM	58,778	23,934	(34,844)	-59.3
WESTON	193,049	139,621	(53,428)	-27.7
WESTWOOD	280,704	248,538	(32,166)	-11.5
WEYMOUTH	1,123,041	1,070,987	(52,054)	-4.6
WILMINGTON	289,198	146,118	(143,080)	-49.5
WINCHESTER	412,044	424,068	12,024	2.9
WINTHROP	425,657	670,495	244,838	57.5
WOBURN	672,717	431,554	(241,163)	-35.8

* 1985 Actuals do not include MTA portion of assessment for inner 14 communities.

The addition of the selected availability measures does not greatly alter the distribution of deficits and there is very little change in the composition of the groups lying more than one standard deviation from the mean in either direction.

The average change for the entire MBTA District is a decline of 26.6% with a standard deviation of 46.5 . The inner 14 show a mean change of +12.2% while the outer 64 show a mean decline of 35.1% .

The communities evidencing the largest positive change (increase in assessments) in going from A1 to A2 are Cohasset (+119%), Scituate (+67%), Weston (+44%), and Needham (+38%). The most plausible explanation is that these communities have proportionately much higher shares of stations than shares of ridership. The only sizeable negative change occurs in Winthrop (40%), which benefits by the fact that there are no stations located there.

D. LEVEL B FORMULAS

1. Net Assessable Costs.

The NAC's to all communities are:

NAC(Rapid Transit) = .747 x (Express)Costs
- .766 x (Express)Revenue - .766 x (Express)Subsidy

NAC(Commuter Rail) = .253 x (Express)Costs
- .233 x (Express)Revenue - .233 x (Express)subsidy

NAC(Local) = (Same as A level)

The actual NAC's used in the simulation are presented in Table 5.8 .

Assumptions.

1. Express costs and revenues are divided between rapid transit and commuter rail on the basis of ratios calculated from the MBTA Modal Cost Allocation-Local Split Model.

2. The general subsidy allocated to express service is divided between rapid transit and commuter rail in proportion to the respective share of revenues.

Table 5.8
Costs and Revenues Split: Rapid Transit and Commuter Rail

CY 1985 PROPOSED

	Rapid Transit	Commuter RR	Total Express
Expenses	210,295,347	71,224,528	281,519,875
Income	55,500,335	16,954,410	72,454,745
Categorical Grants	52,504,749	14,135,473	66,640,222
General Subsidy	80,301,150	24,530,638	104,831,788
Net Assessable Costs	21,989,113	15,604,007	37,593,120

2. Formula B1.

B1 Assessment = NAC(Rapid Transit) x (RC)
+ NAC(Commuter Rail) x (RC) + NAC(Local) x (SLSL)

Results. Table 5.9 reports actual 1985 assessments and those calculated by formula B1, listed by communities. It also reports the difference between the two amounts as well as the percentage change in assessment incurred as a result of moving from the current formula to B1.

Table 5.9
Comparison of 1985 Actual and B1 Computed Assessments

COMMUNITY	ACTUAL*	B1	DIFFERENCE	% DIFF
ARLINGTON	2,030,215	1,752,439	(277,776)	-13.7
ASHLAND	210,109	37,748	(172,361)	-82.0
BEDFORD	226,806	116,848	(109,958)	-48.5
BELMONT	1,041,989	969,666	(72,323)	-6.9
BEVERLY	627,466	1,181,814	554,348	88.3
BOSTON	38,607,284	36,876,677	(1,730,607)	-4.5
BRAINTREE	756,250	907,976	151,726	20.1
BROOKLINE	3,498,557	4,928,287	1,429,730	40.9
BURLINGTON	558,208	464,354	(93,854)	-16.8

COMMUNITY	ACTUAL*	B1	DIFFERENCE	% DIFF
CAMBRIDGE	4,834,190	5,641,324	807,134	16.7
CANTON	326,903	931,644	604,741	185.0
CHELSEA	908,764	955,835	47,071	5.2
COHASSET	115,498	19,607	(95,891)	-83.0
CONCORD	252,749	426,886	174,137	68.9
DANVERS	412,201	401,750	(10,451)	-2.5
DEDHAM	542,393	793,987	251,594	46.4
DOVER	88,102	19,288	(68,814)	-78.1
DUXBURY	180,807	13,556	(167,251)	-92.5
EVERETT	1,378,042	1,575,774	197,732	14.3
FRAMINGHAM	940,159	334,654	(605,505)	-64.4
HAMILTON	130,296	230,604	100,308	77.0
HANOVER	177,582	4,037	(173,545)	-97.7
HINGHAM	398,852	299,217	(99,635)	-25.0
HOLBROOK	249,455	183,029	(66,426)	-26.6
HULL	146,460	42,820	(103,640)	-70.8
LEXINGTON	614,147	251,802	(362,345)	-59.0
LINCOLN	137,726	242,718	104,992	76.2
LYNN	1,264,759	1,638,037	373,278	29.5
LYNNFIELD	209,752	86,273	(123,479)	-58.9
MALDEN	2,105,125	2,622,261	517,136	24.6
MANCHESTER	82,642	274,808	192,166	232.5
MARBLEHEAD	378,114	448,813	70,699	18.7
MARSHFIELD	348,461	8,004	(340,457)	-97.7
MEDFIELD	175,374	109,389	(65,985)	-37.6
MEDFORD	2,480,823	2,855,135	374,312	15.1
MELROSE	641,122	1,141,062	499,940	78.0
MIDDLETON	78,736	14,674	(64,062)	-81.4
MILLIS	131,622	58,804	(72,818)	-55.3
MILTON	937,859	871,427	(66,432)	-7.1
NAHANT	105,818	110,414	4,596	4.3
NATICK	495,894	345,507	(150,387)	-30.3
NEEDHAM	486,023	127,549	(358,474)	-73.8
NEWTON	3,068,468	1,979,352	(1,089,116)	-35.5
NORFOLK	102,601	132,068	29,467	28.7
NORTH READING	208,707	118,870	(89,837)	-43.0
NORWELL	173,961	3,748	(170,213)	-97.8
NORWOOD	586,037	1,188,999	602,962	102.9
PEABODY	744,751	198,581	(546,170)	-73.3
PEMBROKE	244,763	0	(244,763)	-100.0
QUINCY	2,493,112	3,879,883	1,386,771	55.6
RANDOLPH	613,982	438,709	(175,273)	-28.5
READING	462,526	900,310	437,784	94.7
REVERE	1,966,872	2,276,584	309,712	15.7
ROCKLAND	237,272	2,307	(234,965)	-99.0
SALEM	617,920	693,507	75,587	12.2
SAUGUS	532,949	415,244	(117,705)	-22.1
SCITUATE	277,674	22,240	(255,434)	-92.0
SHARON	278,750	736,339	457,589	164.2

COMMUNITY	ACTUAL*	B1	DIFFERENCE	% DIFF
SHERBORN	76,508	56,029	(20,479)	-26.8
SOMERVILLE	3,170,367	3,433,973	263,606	8.3
STONEHAM	369,588	172,358	(197,230)	-53.4
SUDBURY	240,299	65,475	(174,824)	-72.8
SWAMPSCOTT	321,174	423,062	101,888	31.7
TOPSFIELD	99,998	8,400	(91,598)	-91.6
WAKEFIELD	498,390	887,574	389,184	78.1
WALPOLE	332,956	478,653	145,697	43.8
WALTHAM	887,707	669,268	(218,439)	-24.6
WATERTOWN	1,361,303	1,121,805	(239,498)	-17.6
WAYLAND	236,822	22,678	(214,144)	-90.4
WELLESLEY	402,088	815,866	413,778	102.9
WENHAM	58,778	93,381	34,603	58.9
WESTON	193,049	126,367	(66,682)	-34.5
WESTWOOD	280,704	333,420	52,716	18.8
WEYMOUTH	1,123,041	810,566	(312,475)	-27.8
WILMINGTON	289,198	179,946	(109,252)	-37.8
WINCHESTER	412,044	775,816	363,772	88.3
WINTHROP	425,657	570,656	144,999	34.1
WOBURN	672,717	471,536	(201,181)	-29.9

* 1985 Actuals do not include MTA portion of assessment for inner 14 communities.

Under formula B1, only 44 communities experience a decline in assessments; the mean change for the entire region is a 4.2% decline with a standard deviation of 68.9 . The assessments of the inner 14 increase by an average of 4.0% while those of the outer 64 decline by an average of 6.1% .

Manchester's huge percentage increase (+233%) is in fact not very large in dollar terms and can be attributed solely to the new commuter rail service category. This is also essentially the story behind the other two outlyers' increases, Canton (+186%) and Sharon (+164%).

Eight of the inner 14 register increases over actual CY 1985 assessments but these are, in all cases, smaller than those incurred under formula A1; in fact, all inner 14 municipalities benefit from a change in assessment formula from A1 to B1. These communities are not heavy commuter rail users so this new break-

out favors them and these results are consistent with our expectations.

3. Formula B2.

B2 Assessment = NAC(Rapid Transit) x [.8 x RC + .2 x SC]
+ NAC(Commuter Rail) x [.8 x RC + .2 x SC]
+ NAC(Local) x [.8 x SLSL + .2 x RM]

Results. Table 5.10 reports actual 1985 assessments and those calculated by formula B2, listed by communities. It also reports the difference between the two amounts as well as the percentage change in assessment incurred as a result of moving from the current formula to B2.

Table 5.10
Comparison of 1985 Actual and B2 Computed Assessments

COMMUNITY	ACTUAL*	B2	DIFF	%DIFF
ARLINGTON	2,030,215	1,727,121	(303,094)	-14.9
ASHLAND	210,109	30,254	(179,855)	-85.6
BEDFORD	226,806	127,051	(99,755)	-44.0
BELMONT	1,041,989	1,000,104	(41,885)	-4.0
BEVERLY	627,466	1,154,395	526,929	84.0
BOSTON	38,607,284	36,779,782	(1,827,502)	-4.7
BRAINTREE	756,250	1,004,513	248,263	32.8
BROOKLINE	3,498,557	4,728,771	1,230,214	35.2
BURLINGTON	558,208	461,777	(96,431)	-17.3
CAMBRIDGE	4,834,190	5,683,726	849,536	17.6
CANTON	326,903	822,110	495,207	151.5
CHELSEA	908,764	914,021	5,257	0.6
COHASSET	115,498	128,688	13,190	11.4
CONCORD	252,749	417,537	164,788	65.2
DANVERS	412,201	357,315	(54,886)	-13.3
DEDHAM	542,393	732,291	189,898	35.0
DOVER	88,102	15,448	(72,654)	-82.5
DUXBURY	180,807	10,858	(169,949)	-94.0
EVERETT	1,378,042	1,445,464	67,422	4.9
FRAMINGHAM	940,159	305,898	(634,261)	-67.5
HAMILTON	130,296	222,522	92,226	70.8
HANOVER	177,582	3,225	(174,357)	-98.2
HINGHAM	398,852	371,130	(27,722)	-7.0
HOLBROOK	249,455	219,002	(30,453)	-12.2
HULL	146,460	34,222	(112,238)	-76.6

COMMUNITY	ACTUAL*	B2	DIFFERENCE	% DIFF
LEXINGTON	614,147	290,816	(323,331)	-52.6
LINCOLN	137,726	232,229	94,503	68.6
LYNN	1,264,759	1,683,976	419,217	33.1
LYNNFIELD	209,752	69,113	(140,639)	-67.0
MALDEN	2,105,125	2,523,340	418,215	19.9
MANCHESTER	82,642	257,958	175,316	212.1
MARBLEHEAD	378,114	403,181	25,067	6.6
MARSHFIELD	348,461	6,416	(342,045)	-98.2
MEDFIELD	175,374	87,686	(87,688)	-50.0
MEDFORD	2,480,823	2,817,857	337,034	13.6
MELROSE	641,122	1,082,258	441,136	68.8
MIDDLETON	78,736	11,763	(66,973)	-85.1
MILLIS	131,622	47,133	(84,489)	-64.2
MILTON	937,859	1,040,634	102,775	11.0
NAHANT	105,818	101,274	(4,544)	-4.3
NATICK	495,894	352,276	(143,618)	-29.0
NEEDHAM	486,023	269,136	(216,887)	-44.6
NEWTON	3,068,468	2,687,309	(381,159)	-12.4
NORFOLK	102,601	143,539	40,938	39.9
NORTH READING	208,707	95,270	(113,437)	-54.4
NORWELL	173,961	2,994	(170,967)	-98.3
NORWOOD	586,037	1,114,111	528,074	90.1
PEABODY	744,751	159,119	(585,632)	-78.6
PEMBROKE	244,763	0	(244,763)	-100.0
QUINCY	2,493,112	3,759,574	1,266,462	50.8
RANDOLPH	613,982	430,931	(183,051)	-29.8
READING	462,526	768,284	305,758	66.1
REVERE	1,966,872	2,385,552	418,680	21.3
ROCKLAND	237,272	1,843	(235,429)	-99.2
SALEM	617,920	677,319	59,399	9.6
SAUGUS	532,949	439,001	(93,948)	-17.6
SCITUATE	277,674	168,484	(109,190)	-39.3
SHARON	278,750	627,900	349,150	125.3
SHERBORN	76,508	44,912	(31,596)	-41.3
SOMERVILLE	3,170,367	3,259,846	89,479	2.8
STONEHAM	369,588	138,015	(231,573)	-62.7
SUDBURY	240,299	52,480	(187,819)	-78.2
SWAMPSCOTT	321,174	427,256	106,082	33.0
TOPSFIELD	99,998	6,729	(93,269)	-93.3
WAKEFIELD	498,390	825,185	326,795	65.6
WALPOLE	332,956	468,719	135,763	40.8
WALTHAM	887,707	781,758	(105,949)	-11.9
WATERTOWN	1,361,303	1,150,551	(210,752)	-15.5
WAYLAND	236,822	18,179	(218,643)	-92.3
WELLESLEY	402,088	766,919	364,831	90.7
WENHAM	58,778	74,854	16,076	27.3
WESTON	193,049	176,609	(16,440)	-8.5
WESTWOOD	280,704	357,326	76,622	27.3
WEYMOUTH	1,123,041	918,207	(204,834)	-18.2

COMMUNITY	ACTUAL*	B2	DIFFERENCE	% DIFF
WILMINGTON	289,198	219,579	(69,619)	-24.1
WINCHESTER	412,044	732,972	320,928	77.9
WINTHROP	425,657	455,899	30,242	7.1
WOBURN	672,717	508,572	(164,145)	-24.4

* 1985 Actuals do not include MTA portion of assessment for inner 14 communities.

Formula B2 generates results very similar to those of B1. The mean change for the region is a 5.1% decline with a standard deviation of 62.6 . The average inner 14 change is a 5.4% increase and the average outer 64 change is a 7.4% decline. There is again very little change in the composition of the groups lying more than one standard deviation from the mean in either direction.

Communities undergoing the largest increases in the change-over from B1 to B2 are Cohasset (+94%) and Scituate (+53%); those experiencing the largest declines are Sharon (-39%) and Canton (-33%). Despite the declines of the latter two, they still rank third and second, respectively, in overall increase from the actual CY 1985 assessments to the B2 assessments.

E. LEVEL C FORMULAS

1. Net Assessable Costs.

The NAC's for the MBTA district are:

NAC(Orange Line) = .3308 x (Rapid Transit)Costs
- .2809 x (RT Rev + RT subsidy)

NAC(Red) = .3216 x RT Costs - .3390 x (RT Rev + RT subsidy

NAC(Blue) = .0659 x RT Costs - .1111 x (RT Rev + RT subsidy)

NAC(Green) = .2817 x RT Costs - .2690 x (RT Rev + RT subsidy)

NAC(Commuter Rail) = (Same as B level)

NAC(Local) = (Same as A level)

The amounts used for the simulations are presented in Table 5.11 below.

Table 5.11
Costs and Revenues Split: Rapid Transit Line Components

CY 1985 PROPOSED

	Rapid Transit	Orange	Red
Expenses	210,295,347	59,071,963	71,290,123
Income	55,500,335	18,359,512	17,848,907
Categorical Grants	52,504,749	17,368,571	16,885,527
General Subsidy	80,301,150	26,563,620	25,824,850
Net Assessable Costs	21,989,113	- 3,219,740	10,730,839
Adjusted NAC	21,989,113	0	9,183,754

	Blue	Green
Expenses	23,363,813	56,769,448
Income	3,657,472	15,634,444
Categorical Grants	3,460,063	14,790,588
General Subsidy	5,291,846	22,620,834
Net Assessable Costs	10,954,432	3,523,582
Adjusted NAC	10,637,288	2,168,071

Assumptions.

1. Rapid transit costs and revenues are divided among the line components of the service on the basis of ratios calculated from the MBTA Modal Cost Allocation-Local Split Model.

2. The general subsidy allocated to rapid transit is divided among its line components in proportion to the respective share of revenues as calculated from the MBTA Modal Cost Allocation-Local Split Model.

3. The ridership counts for each line are obtained by allocating total rapid transit ridership within a community in proportion to the share of stations serving each line in each community. When there are no stations in a community, ridership is distributed equally across all lines.

4. The Mattapan extension of the red line is allocated to the green line in accordance with MCA procedures.

5. Net assessable costs for the orange line, following the procedure outlined above, are negative; by this method of calculation this line actually runs a surplus (see Table 5.11, above). This surplus is divided among the other three rapid transit lines in proportion to their MCA determined revenues. This means that a community is not assessed for the portion of its ridership which is estimated to occur on the orange line.

2. Formula C1.

C1 Assessment = NAC(Orange) x RC(O) + NAC(Red) x RC(R)
+ NAC(Blue) x RC(B) + NAC(Green) x RC(G)
+ NAC(Commuter Rail) x RC(CR) + NAC(Local) x (SLSL)

Results. Table 5.12 reports actual 1985 assessments and those calculated by formula C1, listed by communities. It also reports the difference between the two amounts as well as the percentage change in assessment incurred as a result of moving from the current formula to C1.

Table 5.12
Comparison of 1985 Actual and C1 Computed Assessments

COMMUNITY	ACTUAL*	C1	DIFF	%DIFF
ARLINGTON	2,030,215	1,780,950	(249,265)	-12.3
ASHLAND	210,109	37,954	(172,155)	-81.9
BEDFORD	226,806	117,053	(109,753)	-48.4
BELMONT	1,041,989	988,114	(53,875)	-5.2
BEVERLY	627,466	1,182,978	555,512	88.5
BOSTON	38,607,284	36,621,912	(1,985,372)	-5.1
BRAINTREE	756,250	967,006	210,756	27.9
BROOKLINE	3,498,557	4,411,572	913,015	26.1
BURLINGTON	558,208	464,833	(93,375)	-16.7
CAMBRIDGE	4,834,190	5,717,950	883,760	18.3
CANTON	326,903	933,287	606,384	185.5
CHELSEA	908,764	971,614	62,850	6.9
COHASSET	115,498	21,934	(93,564)	-81.0
CONCORD	252,749	426,886	174,137	68.9
DANVERS	412,201	402,160	(10,041)	-2.4
DEDHAM	542,393	802,338	259,945	47.9
DOVER	88,102	19,835	(68,267)	-77.5
DUXBURY	180,807	13,898	(166,909)	-92.3

COMMUNITY	ACTUAL*	C1	DIFFERENCE	% DIFF
EVERETT	1,378,042	1,624,513	246,471	17.9
FRAMINGHAM	940,159	336,057	(604,102)	-64.3
HAMILTON	130,296	230,741	100,445	77.1
HANOVER	177,582	4,516	(173,066)	-97.5
HINGHAM	398,852	313,832	(85,020)	-21.3
HOLBROOK	249,455	188,471	(60,984)	-24.4
HULL	146,460	47,269	(99,191)	-67.7
LEXINGTON	614,147	252,520	(361,627)	-58.9
LINCOLN	137,726	243,026	105,300	76.5
LYNN	1,264,759	1,653,919	389,160	30.8
LYNNFIELD	209,752	88,121	(121,631)	-58.0
MALDEN	2,105,125	1,816,649	(288,476)	-13.7
MANCHESTER	82,642	274,808	192,166	232.5
MARBLEHEAD	378,114	453,536	75,422	19.9
MARSHFIELD	348,461	8,004	(340,457)	-97.7
MEDFIELD	175,374	109,389	(65,985)	-37.6
MEDFORD	2,480,823	2,393,797	(87,026)	-3.5
MELROSE	641,122	1,182,340	541,218	84.4
MIDDLETON	78,736	14,674	(64,062)	-81.4
MILLIS	131,622	58,976	(72,646)	-55.2
MILTON	937,859	630,818	(307,041)	-32.7
NAHANT	105,818	112,126	6,308	6.0
NATICK	495,894	346,773	(149,121)	-30.1
NEEDHAM	486,023	129,705	(356,318)	-73.3
NEWTON	3,068,468	1,769,849	(1,298,619)	-42.3
NORFOLK	102,601	132,068	29,467	28.7
NORTH READING	208,707	119,520	(89,187)	-42.7
NORWELL	173,961	4,193	(169,768)	-97.6
NORWOOD	586,037	1,192,045	606,008	103.4
PEABODY	744,751	201,250	(543,501)	-73.0
PEMBROKE	244,763	0	(244,763)	-100.0
QUINCY	2,493,112	4,214,386	1,721,274	69.0
RANDOLPH	613,982	451,133	(162,849)	-26.5
READING	462,526	901,542	439,016	94.9
REVERE	1,966,872	3,732,057	1,765,185	89.7
ROCKLAND	237,272	2,581	(234,691)	-98.9
SALEM	617,920	695,458	77,538	12.5
SAUGUS	532,949	420,960	(111,989)	-21.0
SCITUATE	277,674	24,088	(253,586)	-91.3
SHARON	278,750	737,127	458,377	164.4
SHERBORN	76,508	56,029	(20,479)	-26.8
SOMERVILLE	3,170,367	3,575,718	405,351	12.8
STONEHAM	369,588	178,724	(190,864)	-51.6
SUDBURY	240,299	65,646	(174,653)	-72.7
SWAMPSCOTT	321,174	429,633	108,459	33.8
TOPSFIELD	99,998	8,605	(91,393)	-91.4
WAKEFIELD	498,390	893,324	394,934	79.2
WALPOLE	332,956	479,030	146,074	43.9
WALTHAM	887,707	673,136	(214,571)	-24.2

COMMUNITY	ACTUAL*	C1	DIFFERENCE	% DIFF
WATERTOWN	1,361,303	1,142,272	(219,031)	-16.1
WAYLAND	236,822	22,678	(214,144)	-90.4
WELLESLEY	402,088	820,076	417,988	104.0
WENHAM	58,778	93,381	34,603	58.9
WESTON	193,049	127,907	(65,142)	-33.7
WESTWOOD	280,704	335,919	55,215	19.7
WEYMOUTH	1,123,041	850,851	(272,190)	-24.2
WILMINGTON	289,198	180,562	(108,636)	-37.6
WINCHESTER	412,044	780,300	368,256	89.4
WINTHROP	425,657	637,603	211,946	49.8
WOBURN	672,717	474,548	(198,169)	-29.5

* 1985 Actuals do not include MTA portion of assessment for inner 14 communities.

A smaller majority of communities (46) show a decline in assessments; the mean change for the entire region is a 3.4% decline with a standard deviation of 70.1 . Inner 14 communities experience a 2.9% average increase (smallest of all formulas) while the outer 64 show an average decline of 4.7% (also the smallest of all formulas). The three outlyers on the positive end are the same communities as in B1, Manchester, Canton, and Sharon.

As expected, this level redistributes assessments primarily among communities enjoying rapid transit; those that do not use this service show only trivial changes in going from B1 to C1. Based on the formula and the net assessable costs listed in Table 5.11, we would expect the assessment of communities using primarily Orange and Green line service to decline while expecting those of communities relying on Blue and Red line service to go up, compared to B1 assessment figures.

The communities experiencing the largest decline due to the inclusion of this level (going from B1 to C1) are Malden (-38%), exclusively Orange, Milton (-26%), from stations on the Mattapan extension which is assigned to the Green line by the MCA, and Brookline (-15%), exclusively Green. The municipality experien-

cing the largest increase is Revere (+74%, all Blue line). Boston, parenthetically, shows a 0.6% increase.

3. Formula C2.

C2 Assessment = NAC(O) x [.8 x RC(O) + .2 SC(O)]
+ NAC(R) x [.8 x RC(R) + .2 SC(R)]
+ NAC(B) x [.8 x RC(B) + .2 SC(B)]
+ NAC(G) x [.8 x RC(G) + .2 SC(G)]
+ NAC(Commuter Rail) x [.8 x RC + .2 x SC]
+ NAC(Local) x [.8 x SLSL + .2 x RM]

Results. Table 5.13 reports actual 1985 assessments and those calculated by formula C2, listed by communities. It also reports the difference between the two amounts as well as the percentage change in assessment incurred as a result of moving from the current formula to C2.

Table 5.13
Comparison of 1985 Actual and C2 Computed Assessments

COMMUNITY	ACTUAL*	C2	DIFF	%DIFF
ARLINGTON	2,030,215	1,754,036	(276,179)	-13.6
ASHLAND	210,109	30,448	(179,661)	-85.5
BEDFORD	226,806	127,245	(99,561)	-43.9
BELMONT	1,041,989	1,017,520	(24,469)	-2.3
BEVERLY	627,466	1,155,494	528,028	84.2
BOSTON	38,607,284	37,603,966	(1,003,318)	-2.6
BRAINTREE	756,250	855,946	99,696	13.2
BROOKLINE	3,498,557	5,003,545	1,504,988	43.0
BURLINGTON	558,208	462,229	(95,979)	-17.2
CAMBRIDGE	4,834,190	5,116,759	282,569	5.8
CANTON	326,903	823,661	496,758	152.0
CHELSEA	908,764	928,916	20,152	2.2
COHASSET	115,498	130,885	15,387	13.3
CONCORD	252,749	417,537	164,788	65.2
DANVERS	412,201	357,703	(54,498)	-13.2
DEDHAM	542,393	740,175	197,782	36.5
DOVER	88,102	15,965	(72,137)	-81.9
DUXBURY	180,807	11,181	(169,626)	-93.8
EVERETT	1,378,042	1,491,476	113,434	8.2
FRAMINGHAM	940,159	307,223	(632,936)	-67.3
HAMILTON	130,296	222,651	92,355	70.9

COMMUNITY	ACTUAL*	C2	DIFFERENCE	% DIFF
HANOVER	177,582	3,677	(173,905)	-97.9
HINGHAM	398,852	384,927	(13,925)	-3.5
HOLBROOK	249,455	224,140	(25,315)	-10.1
HULL	146,460	38,422	(108,038)	-73.8
LEXINGTON	614,147	291,494	(322,653)	-52.5
LINCOLN	137,726	232,519	94,793	68.8
LYNN	1,264,759	1,698,969	434,210	34.3
LYNNFIELD	209,752	70,858	(138,894)	-66.2
MALDEN	2,105,125	1,762,650	(342,475)	-16.3
MANCHESTER	82,642	257,958	175,316	212.1
MARBLEHEAD	378,114	407,640	29,526	7.8
MARSHFIELD	348,461	6,416	(342,045)	-98.2
MEDFIELD	175,374	87,686	(87,688)	-50.0
MEDFORD	2,480,823	2,390,752	(90,071)	-3.6
MELROSE	641,122	1,121,226	480,104	74.9
MIDDLETON	78,736	11,763	(66,973)	-85.1
MILLIS	131,622	47,295	(84,327)	-64.1
MILTON	937,859	1,165,541	227,682	24.3
NAHANT	105,818	102,890	(2,928)	-2.8
NATICK	495,894	353,471	(142,423)	-28.7
NEEDHAM	486,023	271,172	(214,851)	-44.2
NEWTON	3,068,468	2,789,668	(278,800)	-9.1
NORFOLK	102,601	143,539	40,938	39.9
NORTH READING	208,707	95,884	(112,823)	-54.1
NORWELL	173,961	3,415	(170,546)	-98.0
NORWOOD	586,037	1,116,987	530,950	90.6
PEABODY	744,751	161,640	(583,111)	-78.3
PEMBROKE	244,763	0	(244,763)	-100.0
QUINCY	2,493,112	2,952,306	459,194	18.4
RANDOLPH	613,982	442,660	(171,322)	-27.9
READING	462,526	769,447	306,921	66.4
REVERE	1,966,872	3,699,899	1,733,027	88.1
ROCKLAND	237,272	2,101	(235,171)	-99.1
SALEM	617,920	679,161	61,241	9.9
SAUGUS	532,949	444,397	(88,552)	-16.6
SCITUATE	277,674	170,229	(107,445)	-38.7
SHARON	278,750	628,643	349,893	125.5
SHERBORN	76,508	44,912	(31,596)	-41.3
SOMERVILLE	3,170,367	2,932,202	(238,165)	-7.5
STONEHAM	369,588	144,025	(225,563)	-61.0
SUDBURY	240,299	52,641	(187,658)	-78.1
SWAMPSCOTT	321,174	433,460	112,286	35.0
TOPSFIELD	99,998	6,923	(93,075)	-93.1
WAKEFIELD	498,390	830,614	332,224	66.7
WALPOLE	332,956	469,074	136,118	40.9
WALTHAM	887,707	785,409	(102,298)	-11.5
WATERTOWN	1,361,303	1,169,873	(191,430)	-14.1
WAYLAND	236,822	18,179	(218,643)	-92.3
WELLESLEY	402,088	770,893	368,805	91.7

COMMUNITY	ACTUAL*	C2	DIFFERENCE	% DIFF
WENHAM	58,778	74,854	16,076	27.3
WESTON	193,049	178,063	(14,986)	-7.8
WESTWOOD	280,704	359,684	78,980	28.1
WEYMOUTH	1,123,041	956,238	(166,803)	-14.9
WILMINGTON	289,198	220,161	(69,037)	-23.9
WINCHESTER	412,044	737,205	325,161	78.9
WINTHROP	425,657	519,100	93,443	22.0
WOBURN	672,717	511,415	(161,302)	-24.0

* 1985 Actuals do not include MTA portion of assessment for inner 14 communities.

The changes resulting from the imposition of level 2 on C formulas very much conform to the changes in going from 1 to 2 for all levels. The mean change for the region is a 4.7% decline with a standard deviation of 63.2. Inner 14 municipalities register a mean change of +7.3% while outer 64 assessments decline by the same average of 7.3% . The explanation for the effect of C2 lies in a combination of those detailed in A2, B2, and C1.

F. GENERAL RESULTS

1. Summary of Formulas.

In order to more easily see the implications of the various new formulas we present a comparison of the percentage changes in assessment from 1985 actual in Table 5.14 .

Table 5.14
Percentage Change in Assessments

COMMUNITY	A1	A2	B1	B2	C1	C2
ARLINGTON	-9.5	-11.6	-13.7	-14.9	-12.3	-13.6
ASHLAND	-93.3	-94.6	-82.0	-85.6	-81.9	-85.5
BEDFORD	-55.3	-49.5	-48.5	-44.0	-48.4	-43.9
BELMONT	-4.4	.0	-6.9	-4.0	-5.2	-2.3
BEVERLY	-27.1	-0.7	88.3	84.0	88.5	84.2

COMMUNITY	A1	A2	B1	B2	C1	C2
BOSTON	5.9	2.6	-4.5	-4.7	-5.1	-2.6
BRAINTREE	38.8	49.0	20.1	32.8	27.9	13.2
BROOKLINE	51.3	42.0	40.9	35.2	26.1	43.0
BURLINGTON	-21.0	-20.6	-16.8	-17.3	-16.7	-17.2
CAMBRIDGE	32.4	29.0	16.7	17.6	18.3	5.8
CANTON	-3.8	6.1	185.0	151.5	185.5	152.0
CHELSEA	11.3	5.5	5.2	0.6	6.9	2.2
COHASSET	-74.8	43.7	-83.0	11.4	-81.0	13.3
CONCORD	-45.9	-19.1	68.9	65.2	68.9	65.2
DANVERS	-36.7	-40.7	-2.5	-13.3	-2.4	-13.2
DEDHAM	-7.5	-6.4	46.4	35.0	47.9	36.5
DOVER	-86.9	-89.5	-78.1	-82.5	-77.5	-81.9
DUXBURY	-95.7	-96.6	-92.5	-94.0	-92.3	-93.8
EVERETT	23.1	11.9	14.3	4.9	17.9	8.2
FRAMINGHAM	-87.1	-84.6	-64.4	-67.5	-64.3	-67.3
HAMILTON	-42.3	-17.3	77.0	70.8	77.1	70.9
HANOVER	-96.6	-97.3	-97.7	-98.2	-97.5	-97.9
HINGHAM	-11.7	8.7	-25.0	-7.0	-21.3	-3.5
HOLBROOK	-20.3	-3.2	-26.6	-12.2	-24.4	-10.1
HULL	-60.9	-68.7	-70.8	-76.6	-67.7	-73.8
LEXINGTON	-59.1	-52.7	-59.0	-52.6	-58.9	-52.5
LINCOLN	-41.3	-18.5	76.2	68.6	76.5	68.8
LYNN	28.2	33.7	29.5	33.1	30.8	34.3
LYNNFIELD	-78.2	-82.6	-58.9	-67.0	-58.0	-66.2
MALDEN	39.7	31.0	24.6	19.9	-13.7	-16.3
MANCHESTER	6.5	42.8	232.5	212.1	232.5	212.1
MARBLEHEAD	-25.9	-29.1	18.7	6.6	19.9	7.8
MARSHFIELD	-99.3	-99.4	-97.7	-98.2	-97.7	-98.2
MEDFIELD	-80.0	-84.0	-37.6	-50.0	-37.6	-50.0
MEDFORD	22.8	19.7	15.1	13.6	-3.5	-3.6
MELROSE	48.3	49.6	78.0	68.8	84.4	74.9
MIDDLETON	-94.0	-95.2	-81.4	-85.1	-81.4	-85.1
MILLIS	-84.4	-87.5	-55.3	-64.2	-55.2	-64.1
MILTON	10.9	20.7	-7.1	11.0	-32.7	24.3
NAHANT	4.1	-4.5	4.3	-4.3	6.0	-2.8
NATICK	-75.2	-61.0	-30.3	-29.0	-30.1	-28.7
NEEDHAM	-77.0	-39.1	-73.8	-44.6	-73.3	-44.2
NEWTON	-36.0	-14.3	-35.5	-12.4	-42.3	-9.1
NORFOLK	-58.8	-20.6	28.7	39.9	28.7	39.9
NORTH READIN	-78.7	-83.0	-43.0	-54.4	-42.7	-54.1
NORWELL	-96.8	-97.4	-97.8	-98.3	-97.6	-98.0
NORWOOD	-7.2	6.9	102.9	90.1	103.4	90.6
PEABODY	-87.9	-90.4	-73.3	-78.6	-73.0	-78.3
PEMBROKE	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0
QUINCY	88.7	75.5	55.6	50.8	69.0	18.4
RANDOLPH	-23.7	-25.9	-28.5	-29.8	-26.5	-27.9
READING	-25.2	-27.9	94.7	66.1	94.9	66.4
REVERE	34.2	34.5	15.7	21.3	89.7	88.1
ROCKLAND	-98.6	-98.8	-99.0	-99.2	-98.9	-99.1

COMMUNITY	A1	A2	B1	B2	C1	C2
SALEM	-32.4	-24.6	12.2	9.6	12.5	9.9
SAUGUS	-20.3	-16.2	-22.1	-17.6	-21.0	-16.6
SCITUATE	-90.9	-24.2	-92.0	-39.3	-91.3	-38.7
SHARON	-12.6	-13.0	164.2	125.3	164.4	125.5
SHERBORN	-76.5	-81.2	-26.8	-41.3	-26.8	-41.3
SOMERVILLE	18.3	10.5	8.3	2.8	12.8	-7.5
STONEHAM	-68.2	-74.6	-53.4	-62.7	-51.6	-61.0
SUDBURY	-90.6	-92.5	-72.8	-78.2	-72.7	-78.1
SWAMPSCOTT	-6.5	5.4	31.7	33.0	33.8	35.0
TOPSFIELD	-95.3	-96.2	-91.6	-93.3	-91.4	-93.1
WAKEFIELD	0.7	7.5	78.1	65.6	79.2	66.7
WALPOLE	-44.8	-24.3	43.8	40.8	43.9	40.9
WALTHAM	-30.6	-14.5	-24.6	-11.9	-24.2	-11.5
WATERTOWN	-12.3	-11.2	-17.6	-15.5	-16.1	-14.1
WAYLAND	-96.9	-97.5	-90.4	-92.3	-90.4	-92.3
WELLESLEY	-24.7	-4.3	102.9	90.7	104.0	91.7
WENHAM	-49.1	-59.3	58.9	27.3	58.9	27.3
WESTON	-71.2	-27.7	-34.5	-8.5	-33.7	-7.8
WESTWOOD	-38.3	-11.5	18.8	27.3	19.7	28.1
WEYMOUTH	-15.3	-4.6	-27.8	-18.2	-24.2	-14.9
WILMINGTON	-78.0	-49.5	-37.8	-24.1	-37.6	-23.9
WINCHESTER	-11.1	2.9	88.3	77.9	89.4	78.9
WINTHROP	96.9	57.5	34.1	7.1	49.8	22.0
WOBURN	-46.0	-35.8	-29.9	-24.4	-29.5	-24.0
DISTRICT MEAN	-34.1	-26.6	-4.3	-5.1	-3.4	-4.7
INNER 14 MEAN	13.4	12.2	4.0	5.4	2.9	7.3
OUTER 64 MEAN	-44.5	-35.1	-6.1	-7.4	-4.7	-7.3

A change from the current assessment formula to any of those recommended in this study implies significant changes in the pattern of assessments for the communities of the MBTA district. This change in pattern is itself dependent upon which of the recommended formulas is selected.

The first suggested change (level A) leads to a new allocation of the general subsidy and favors those communities with little bus service, primarily the outer 64. It also penalizes communities with post 1973 express stations as well as those whose residents make heavy use of neighboring express stations.

Breaking out commuter rail, as is done in level B, adversely affects many of the outer 64 communities since costs are propor-

tionately higher and revenues lower than other express services. This serves to mitigate the burden shift to local service which was introduced by level A since heavy bus users are also generally light commuter rail users. Level C primarily redistributes B level assessments within the small group of heavy rapid transit users.

The group means at the bottom of Table 5.14 further indicate that the redistribution in assessments resulting from the imposition of A level changes heavily benefits outer 64 communities at the expense of the inner 14. Level C formulas, on the other hand, seem to effect the most neutral change from a group perspective although the range of assessments is the broadest.

It appears that second level formulas which include availability measures do not greatly alter the distribution of assessments. In principle, these measures reduce inequity but their use very much depends on the confidence associated with their proxies. The measures used in these simulations are not especially reliable and would not warrant inclusion; more accurate proxies should be developed.

2. Per Capita Costs Under New Formulas.

Another perspective on the new formulas may be gained by comparing the actual dollar contributions of each community. In order to control for community size, we present per capita expenditures under current and suggested formulas in Table 5.15 .

Although this type of information is useful for the consideration of vertical equity, the topic is outside the scope of this study; consequently, we present the following data with summary comments only.

Table 5.15
Per Capita Assessments

COMMUNITY	1985	A1	A2	B1	B2	C1	C2
ARLINGTON	42.10	38.11	37.23	36.34	35.82	36.93	36.38
ASHLAND	22.93	1.54	1.23	4.12	3.30	4.14	3.32
BEDFORD	17.36	7.76	8.77	8.94	9.72	8.96	9.74
BELMONT	39.92	38.18	39.90	37.15	38.32	37.86	38.99
BEVERLY	16.66	12.15	16.54	31.39	30.66	31.42	30.69
BOSTON	68.57	72.60	70.38	65.50	65.33	65.05	66.79
BRAINTREE	20.81	28.88	31.01	24.99	27.64	26.61	23.56
BROOKLINE	63.54	96.13	90.20	89.50	85.88	80.12	90.87
BURLINGTON	23.77	18.77	18.86	19.77	19,66	19.79	19.68
CAMBRIDGE	50.71	67.15	65.43	59.18	59.63	59.99	53.68
CANTON	17.98	17.30	19.08	51.24	45.22	51.33	45.30
CHELSEA	35.73	39.79	37.71	37.59	35.94	38.21	36.53
COHASSET	16.10	4.05	23.14	2.73	17.94	3.06	18.24
CONCORD	15.51	8.39	12.56	26.20	25.63	26.20	25.63
DANVERS	17.10	10.83	10.14	16.67	14.83	16.69	14.84
DEDHAM	21.44	19.82	20.06	31.39	28.95	31.72	29.26
DOVER	18.73	2.45	1.96	4.10	3.28	4.22	3.39
DUXBURY	15.31	0.65	0.52	1.15	0.92	1.18	0.95
EVERETT	37.05	45.59	41.45	42.37	38.86	43.68	40.10
FRAMINGHAM	14.44	1.86	2.22	5.14	4.70	5.16	4.72
HAMILTON	18.72	10.81	15.48	33.13	31.97	33.15	31.99
HANOVER	15.63	0.53	0.42	0.36	0.28	0.40	0.32
HINGHAM	19.61	17.32	21.31	14.71	18.25	15.43	18.93
HOLBROOK	22.39	17.84	21.68	16.43	19.66	16.92	20.12
HULL	15.08	5.90	4.72	4.41	3.52	4.87	3.96
LEXINGTON	20.83	8.52	9.85	8.54	9.87	8.57	9.89
LINCOLN	19.40	11.38	15.81	34.20	32.72	34.24	32.76
LYNN	16.12	20.67	21.55	20.87	21.46	21.08	21.65
LYNNFIELD	18.62	4.06	3.25	7.66	6.13	7.82	6.29
MALDEN	39.43	55.11	51.66	49.12	47.27	34.03	33.02
MANCHESTER	15.24	16.23	21.76	50.67	47.56	50.67	47.56
MARBLEHEAD	18.79	13.93	13.32	22.30	20.03	22.53	20.25
MARSHFIELD	16.66	0.12	0.10	0.38	0.31	0.38	0.31
MEDFIELD	17.16	3.43	2.74	10.70	8.58	10.70	8.58
MEDFORD	42.72	52.45	51.14	49.16	48.52	41.22	41.17
MELROSE	21.33	31.63	31.92	37.97	36.01	39.34	37.31
MIDDLETON	19.04	1.14	0.91	3.55	2.84	3.55	2.84
MILLIS	19.05	2.97	2.38	8.51	6.82	8.54	6.85
MILTON	36.27	40.21	43.77	33.70	40.24	24.39	45.07
NAHANT	26.81	27.90	25.60	27.97	25.66	28.41	26.07
NATICK	16.83	4.18	6.57	11.72	11.95	11.77	11.99
NEEDHAM	17.42	4.01	10.62	4.57	9.65	4.65	9.72
NEWTON	36.69	23.49	31.43	23.67	32.14	21.16	33.36
NORFOLK	16.12	6.65	12.80	20.76	22.56	20.76	22.56
NORTH READING	18.22	3.88	3.10	10.38	8.32	10.43	8.37
NORWELL	18.95	0.61	0.48	0.41	0.33	0.46	0.37

COMMUNITY	85PC	A1PC	A2PC	B1PC	B2PC	C1PC	C2PC
NORWOOD	19.72	18.31	21.08	40.02	37.50	40.12	37.60
PEABODY	16.20	1.95	1.56	4.32	3.46	4.38	3.52
PEMBROKE	18.15	0.00	0.00	0.00	0.00	0.00	0.00
QUINCY	29.42	55.50	51.65	45.78	44.36	49.73	34.84
RANDOLPH	21.76	16.60	16.11	15.55	15.27	15.99	15.69
READING	20.40	15.25	14.70	39.70	33.88	39.75	33.93
REVERE	46.36	62.24	62.34	53.66	56.23	87.97	87.21
ROCKLAND	15.12	0.22	0.17	0.15	0.12	0.16	0.13
SALEM	16.17	10.93	12.19	18.15	17.72	18.20	17.77
SAUGUS	21.54	17.17	18.05	16.78	17.74	17.01	17.96
SCITUATE	16.03	1.46	12.16	1.28	9.73	1.39	9.83
SHARON	20.49	17.91	17.83	54.14	46.17	54.20	46.22
SHERBORN	18.90	4.43	3.55	13.84	11.09	13.84	11.09
SOMERVILLE	40.98	48.47	45.27	44.38	42.13	46.21	37.90
STONEHAM	17.25	5.49	4.39	8.05	6.44	8.34	6.72
SUDBURY	17.13	1.61	1.29	4.67	3.74	4.68	3.75
SWAMPSCOTT	23.21	21.69	24.47	30.57	30.88	31.05	31.33
TOPSFIELD	17.52	0.82	0.66	1.47	1.18	1.51	1.21
WAKEFIELD	20.02	20.17	21.52	35.65	33.15	35.88	33.36
WALPOLE	17.66	9.74	13.36	25.38	24.85	25.40	24.87
WALTHAM	15.25	10.59	13.04	11.50	13.43	11.57	13.50
WATERTOWN	39.59	34.73	35.15	32.63	33.46	33.22	34.02
WAYLAND	19.47	0.60	0.48	1.86	1.49	1.86	1.49
WELLESLEY	14.78	11.12	14.14	29.99	28.19	30.14	28.33
WENHAM	15.08	7.68	6.14	23.96	19.21	23.96	19.21
WESTON	17.28	4.97	12.50	11.31	15.81	11.45	15.94
WESTWOOD	21.25	13.10	18.81	25.24	27.05	25.43	27.22
WEYMOUTH	20.20	17.11	19.26	14.58	16.51	15.30	17.20
WILMINGTON	16.55	3.64	8.36	10.30	12.57	10.33	12.60
WINCHESTER	19.90	17.69	20.49	37.48	35.41	37.69	35.61
WINTHROP	22.06	43.44	34.75	29.58	23.63	33.05	26.90
WOBURN	18.37	9.92	11.78	12.87	13.89	12.96	13.96
DISTRICT MEAN	23.24	18.22	19.36	23.03	22.83	23.21	23.01
INNER 14 MEAN	44.26	51.02	50.22	46.71	47.13	46.43	48.22
OUTER 64 MEAN	18.64	11.05	12.61	17.85	17.52	18.13	17.50

Currently, the CY 1985 average per capita assessments for the inner 14 is more than twice that of the outer 64; in fact the lowest per capita assessment for the inner 14 (Chelsea, $35.73) exceeds the highest per capita assessment of the outer 64 (Quincy, $29.42). As before, the effect of level A formulas is to increase the gap between the two group means while level B and C formulas reduce these differences. Not surprisingly, the range

is again broadened from a high of $96.13 (Brookline, A1) to a low of $21.16 (Newton, C1) for the inner 14. Outer 64 figures range from $55.50 (Quincy, A1) to 0 (Pembroke, A1-C2).

G. BENEFITS OF NEW FORMULA

1. Changing the General Subsidy Allocation.

1.1 Separating out the allocation of general subsidy between service types puts the decision in the proper political arena and forces consideration of the issue. This is clearly an improvement over the arbitrary ratios currently in use.

1.2 There is no longer any justification for the special legislative rebates which presently benefit some 23 communities since net assessable costs are apportioned strictly on the basis of service utilization.

1.3 The distortion in the formula introduced by fixing at 30% Boston's share of the portion of express and local assessments based on commuters and population, respectively, is eliminated. This is because the public benefit portion of the system is now accounted for in the allocation of the general subsidy rather than being based on population or commuters.

1.4 The historical distinction between inner 14/outer 64 communities in assessing local deficits is also eliminated for the same reasons as 1.3 above.

2. Benefits of Ridership Measures.

2.1 When stations border other communities and simple boarding counts are used, a significant portion of riders charged to a community come from elsewhere. Using ridership surveys which take account of originating jurisdiction eliminates a major complaint of communities with express stations.

2.2 Partially as compensation for the problem discussed in 2.1, express stations opened after June 1973 are not included in boarding counts. This is a gross distortion of utilization pat-

terns which can be eliminated by using ridership surveys. Furthermore, communities no longer have incentives to resist new stations since they capture the majority of benefits while incurring more reasonable charges.

3. Benefits from Using Revenue Driven Allocation Ratios for Service Components.

Distributing express subsidy among line components on the basis of revenues generated provides double incentives for increasing ridership. Net assessable costs decline because revenues rise and because the proportion of general subsidies received also rises.

4. More Efficient Local Service Provision.

Since 100% of local service assessment is now based on actual deficits incurred within a community, jurisdictions now have greater incentives to monitor their routes and petition for changes. This has the potential to make local service more efficient in the long run; whether or not it does depends largely on the degree to which municipalities are permitted to make their preferences for individual routes count in service planning. Some community representatives have expressed dissatisfaction with their level of involvement in route selection but any mechanism which regularly incorporates municipal preferences must also strike a difficult balance between local and system-wide objectives.

H. DRAWBACKS OF THE NEW FORMULAS

1. Complexity.

It is certain that these formulas raise the level of complexity in the assessment process. This in itself is undesirable but the technical requirements are manageable and certain to generate benefits for other aspects of service planning.

The most formidable obstacle is devising a mechanism for bringing the Advisory Board on a regular basis into the first part of the process of determining the allocation of the general subsidy. However, despite the anticipated difficulty, it should be recognized that most of the benefits enumerated above result from the successful completion of this task.

2. Costs.

The technical requirements alluded to above are sure to generate sizable additional costs, particularly the ridership surveys. It is difficult to urge that scarce resources be devoted to administrative functions but we believe a strong case has been made for the presence of significant payoffs to undertaking these surveys. Benefits which are subtle and less easily quantifiable than costs are real nevertheless.

3. Disincentive Effects of Ridership Measures.

The major criticism of ridership measures is that they provide disincentives to communities for promoting service utilization since this leads to raised assessments. While the outcome of this proposition is undeniably true, we have structured the allocation of express subsidy among service components to somewhat offset this tendency.

Parenthetically, the premise that ridership measures lead to disincentives may deserve examination. When a community encourages an additional resident to board a train, its assessment rises by some insignificant amount. This amount plus the fare is the marginal cost of that additional ride, but the amount of subsidy from outside the community for that ride far outweighs these costs. Hence the sum of a community's welfare will rise as ridership rises as long as subsidies exceed fares and assessments in spite of the growth in the latter.

I. IMPLEMENTING CHANGES

The current formula has been in place in its basic form since 1964. Although there is widespread dissatisfaction with it, there will never be unanimous approval of any alternative. Two factors may help raise the degree of acceptance.

1. The results of the simulation indicate that some communities may face significantly higher burdens if these recommendations are adopted. While we maintain that these changes reflect more accurate valuations of benefits received, it may be desirable to invoke legislative assistance and facilitate the transition through partial subsidization. This assistance should be for a clearly defined, short-term time period and limited to relief for the adjustment costs of moving from one formula to another.

2. Since the new formulas consist of a two step process, it is possible to institute change gradually by altering one or the other component singly. This should spread the full transfer effects over a longer period of time and make them more tolerable.

Appendix A

EQUITY MODEL SELECTION

There are two major difficulties to be resolved in specifying an alternative model to explain per capita assessments. The first frequently occurs with cross-sectional data when the units of observation (the communities in this case) vary greatly in size.

When the above is true, it is likely that one of the fundamental assumptions of simple least squares has been violated, that of a common variance for the error terms. This condition, known as heteroscedasticity, leads to unbiased but inefficient estimates of the coefficients and biased estimates of the variances. The standard solution, which is applied here, is to use weighted least squares by deflating the variables by a series assumed to be proportional to the variance (in this case population).

The second problem is that there is no a priori theoretical basis for selecting independent variables to include in the regression. The temptation is to indiscriminantly expand the set of regressors with any variable which can be remotely considered relevant to the dependent variable. While this obviously will increase the variance accounted for by the model, it will also, given the high correlation among the available explanatory variables, undoubtedly lead to multicollinearity. When this occurs, we end up with a very high R^2 but few significant coefficients so that the fitted values are largely meaningless.

To solve this problem, we fitted four progressively more restrictive models to the data and tested by likelihood ratios the joint hypothesis each represents. Results from the estimations appear in Table A.1 .

Table A.1
Estimation Results

Variable	Model 1	2	3	4
CONS	-20.4335	13.5791	15.5675**	15.4912**
DENS	-0.00072**	-0.00079**	-0.00078**	-0.00079**
TTIME	-0.2317	-0.3495	-0.35689	-0.35751*
%PUB	1.741**	1.6719**	1.6722**	1.6721**
MAGE	0.40473	0.05341	-	-
MINC	-0.00016	0	0	-
MSIZE	0.26928	-	-	-
MWRK	15.0132*	-	-	-
R^2	0.940101	0.936952	0.936927	0.936926
L	-254.504	-256.502	-256.518	-256.518

* Significant at the .10 level.
** Significant at the .05 level.

The variables DENS, TTIME, and %PUB are those described earlier in chapter IV. MAGE is mean household age, MINC is mean household income, MSIZE is mean household size, and MWRK is mean number of workers in the household. L is the log of the likelihood function.

Models 2-4 specified above are nested within model 1; that is each is a specific case of model 1 with a particular hypothesis which restricts one or more of the coefficients to equal 0. The appropriate method for hypothesis testing in this case is a comparison of the maxima of the likelihood functions for sequential pairs of models.

The test statistic (λ) is a ratio of the value of the likelihood function for the restricted model (L^*) to the value of the likelihood function for the unrestricted model (L). This statistic is unbiased and consistent but its distribution depends specifically on the hypothesis being tested and is therefore incalculable for all but the very simplest tests. What must be used, consequently, is the asymptotic equivalent of the statistic where $-2(\log\lambda)$ is distributed with degrees of freedom equal to the

difference in the number of parameters of the two models and equal to a specified value for the type I error. HO is rejected if $= L^*/L$ is small but since $-2(\log\lambda)$ increases as λ decreases, the test rejects HO for large values of $-2(\log\lambda)$. Therefore, a test of approximate size α is:
Reject HO iff $-2(\log\lambda) = -2(\log L^* - \log L) > \chi^2_{(1-\alpha),r}$ where the right hand term is the $(1-\alpha)$th quantile of a chi-square distribution with r degrees of freedom.

This test is applied to the four hypotheses considered in the following manner; the results are described below.

λ_1 : HO: Model 2.
H1: Model 1.

λ_2 : HO: Model 3.
H1: Model 2.

λ_3 : HO: Model 4.
H1: Model 3.

Table A.2
Hypotheses Tests

Test	α	r	χ^2	λ	Conclusion
λ_1 = -2(logL2-logL1)	.05	2	6.00	3.996	Do not Reject HO
λ_2 = -2(logL3-logL2)	.05	1	3.84	0.032	Do not Reject HO
λ_3 = -2(logL4-logL3)	.05	1	3.84	0.000	Do not Reject HO

Finally, we present the data set used for the selected regression. In addition to the variables previously discussed in chapter IV, Table A.3 contains the following information:

R: Served (0) and non-served (1) communities.

F: Inner fourteen (1) and outer sixty-four (0) communities.

S: Communities containing no express stations (0), post-1973 express stations only (1), pre-1973 stations only (2) and both pre and post-1973 stations (3).

Table A.3
Input Data and Descriptive Characteristics

COMMUNITY	R	F	S	PCASS	DENS	TTIME	%PUB
ARLINGTON	0	1	0	42.85	9308	26.8	21.88
ASHLAND	1	0	0	14.81	739	21.3	2.05
BEDFORD	0	0	0	14.54	952	17.9	1.83
BELMONT	0	1	2	38.75	5686	23.2	17.87
BEVERLY	0	0	2	14.09	2487	20.4	5.98
BOSTON	0	1	2	64.69	13038	25.3	39.96
BRAINTREE	0	0	1	18.42	2652	23.1	9.38
BROOKLINE	0	1	2	58.48	8318	25.1	30.65
BURLINGTON	0	0	0	15.95	1984	19.5	3.02
CAMBRIDGE	0	1	3	52.15	15252	21.4	37.65
CANTON	0	0	2	13.29	956	23.5	9.75
CHELSEA	0	1	0	36.36	13673	21.0	27.17
COHASSET	1	0	0	12.38	728	32.8	9.37
CONCORD	0	0	2	12.37	653	21.8	5.33
DANVERS	0	0	0	15.74	1767	18.0	2.06
DEDHAM	0	0	2	18.46	2419	22.4	8.46
DOVER	1	0	0	14.41	310	28.7	8.89
DUXBURY	1	0	0	8.48	485	33.6	7.39
EVERETT	0	1	0	38.74	11070	22.9	22.01
FRAMINGHAM	0	0	2	12.02	2722	21.5	3.43
HAMILTON	0	0	2	15.08	475	23.8	5.67
HANOVER	1	0	0	12.70	735	27.7	6.19
HINGHAM	0	0	0	14.99	906	27.7	11.54
HOLBROOK	0	0	0	20.41	1526	25.4	6.97
HULL	1	0	0	14.96	3998	33.8	6.81
LEXINGTON	0	0	0	18.23	1789	21.9	6.02
LINCOLN	0	0	2	18.23	487	20.8	8.38
LYNN	0	0	2	16.93	7495	20.1	11.55
LYNNFIELD	1	0	0	14.62	1102	21.9	2.61
MALDEN	0	1	1	36.92	10509	23.6	21.26
MANCHESTER	0	0	2	11.95	703	23.7	9.38
MARBLEHEAD	0	0	0	17.14	4574	26.9	7.13
MARSHFIELD	1	0	0	10.33	738	30.9	4.41
MEDFIELD	1	0	0	12.11	708	25.7	3.90
MEDFORD	0	1	3	41.87	7074	23.5	21.30
MELROSE	0	0	2	19.81	6354	22.7	15.10
MIDDLETON	1	0	0	13.85	290	18.8	0.97
MILLIS	1	0	0	11.60	568	26.8	3.59
MILTON	0	1	2	36.40	1974	26.3	16.27
NAHANT	0	0	0	25.68	3795	24.7	7.84
NATICK	0	0	3	14.72	1979	20.5	5.13
NEEDHAM	0	0	0	15.16	2232	21.9	9.95
NEWTON	0	1	2	35.32	4672	22.2	13.83
NORFOLK	0	0	2	10.04	421	24.2	4.20
NORTH READING	1	0	0	15.98	864	23.6	2.60
NORWELL	1	0	0	13.56	438	29.1	5.33

COMMUNITY	R	F	S	PCASS	DENS	TTIME	%PUB
NORWOOD	0	0	2	16.53	2838	22.2	7.75
PEABODY	1	0	0	14.76	2795	20.1	2.24
PEMBROKE	1	0	0	12.87	626	29.8	3.75
QUINCY	0	0	3	27.24	5133	24.7	22.22
RANDOLPH	0	0	0	18.00	2799	25.0	6.51
READING	0	0	2	16.50	2305	21.2	6.36
REVERE	0	1	2	43.70	7130	23.8	23.15
ROCKLAND	1	0	0	13.27	1566	22.0	2.61
SALEM	0	0	2	14.99	4783	18.4	5.76
SAUGUS	0	0	0	21.32	2339	21.0	7.38
SCITUATE	1	0	0	12.86	1025	32.2	5.11
SHARON	0	0	2	15.67	577	28.8	9.60
SHERBORN	1	0	0	12.50	240	27.8	3.31
SOMERVILLE	0	1	1	41.92	19687	23.8	31.08
STONEHAM	1	0	0	15.25	3553	19.9	4.61
SUDBURY	1	0	0	13.47	576	26.1	2.69
SWAMPSCOTT	0	0	2	19.52	4493	24.9	9.81
TOPSFIELD	1	0	0	13.16	446	23.9	1.87
WAKEFIELD	0	0	2	17.15	3387	21.0	6.60
WALPOLE	0	0	2	13.97	917	22.3	5.54
WALTHAM	0	0	2	14.28	4690	18.0	6.12
WATERTOWN	0	1	0	36.05	8469	20.5	17.97
WAYLAND	1	0	0	15.95	796	23.5	2.52
WELLESLEY	0	0	2	14.13	2707	22.2	12.73
WENHAM	1	0	0	14.02	503	17.6	4.82
WESTON	0	0	2	13.79	650	22.6	7.28
WESTWOOD	0	0	2	17.11	1185	25.4	8.15
WEYMOUTH	0	0	0	17.36	3329	24.8	8.13
WILMINGTON	0	0	3	13.26	1023	21.8	2.37
WINCHESTER	0	0	2	17.60	3509	21.6	8.79
WINTHROP	0	0	0	21.46	12368	26.7	27.75
WOBURN	0	0	1	16.53	2848	18.8	4.15
AVERAGE				20.77	3473	23.7	9.88
MAXIMUM				64.69	19687	33.8	39.96
MINIMUM				8.48	240	17.6	0.97

Appendix B

DATA SET

Table B.1
Variable Definition and Index of New Assessment Formulas

Ridership Count	RC	% of total number of riders using service category who originate from a community
Share of Losses	SLSL	% of losses incurred by all local service attributable to a community
Number of Stations	SC	% of rapid transit or rail stations located or assigned to a community
Route Miles	RM	% of total route miles located within a community

Level A Net Assessable Costs
Express: NACE = E Costs - E Revenues - .65 x subsidy
Local : NACL = L Costs - L Revenues - .35 x subsidy
A1 Assessment = NACE x (RC) + NACL x (SLSL)
A2 Assessment = .8(NACE) x (RC) + .2(NACE) x (SC)
+ .8(NACL) x (SLSL) + .2(NACL) x (RM)

Level B Net Assessable Costs
Rapid Transit: NACR = .747 xE Costs - .766 x(E Rev + E subsidy)
Commuter Rail: NACC = .253 xE Costs - .233 x(E Rev + E subsidy)
Local : NACL = L Costs - L Revenues - L subsidy
B1 Assessment = NACR x (RC) + NACC x (RC) + NACL x (SLSL)
B2 Assessment = .8(NACR) x (RC) + .2(NACR) x (SC)
+ .8(NACC) x (RC) + .2(NACC) x (SC)
+ .8(NACL) x (SLSL) + .2(NACL) x (RM)

Level C Net Assessable Costs
Orange Line: NACO = .3308xRT Costs - .2809x(RT Rev + RT subsidy)
Red Line : NACR = .3216xRT Costs - .3390x(RT Rev + RT subsidy)
Blue Line : NACB = .0659xRT Costs - .1111x(RT Rev + RT subsidy)
Green Line : NACG = .2817xRT Costs - .2690x(RT Rev + RT subsidy)
Com. Rail: NACC = .253 xE Costs - .233 x(E Rev + E subsidy)
Local : NACL = L Costs - L Revenues - L subsidy
C1 Assessment = NACOxRC + NACRxRC + NACBxRC + NACGxRC
+ NACC x (RC) + NACL x (SLSL)
C2 Assessment = .8(NACO) x (RC) + .2(NACO) x (SC)
+ .8(NACR) x (RC) + .2(NACR) x (SC)
+ .8(NACB) x (RC) + .2(NACB) x (SC)
+ .8(NACG) x (RC) + .2(NACG) x (SC)
+ .8(NACC) x (RC) + .2(NACC) x (SC)
+ .8(NACL) x (SLSL) + .2(NACL) x (RM)

Table B.2
Level 1 Usage Shares

COMMUNITY	LOCAL	EXPRESS	COMRAIL	RAPID T	RED L	GREEN L	BLUE L
ARLINGTON	0.0256	0.0099	0.0029	0.0109	0.0077	0.0101	0.0165
ASHLAND	0.0000	0.0004	0.0023	0.0001	0.0001	0.0001	0.0001
BEDFORD	0.0016	0.0003	0.0015	0.0001	0.0001	0.0001	0.0001
BELMONT	0.0130	0.0067	0.0045	0.0071	0.0050	0.0065	0.0107
BEVERLY	0.0017	0.0095	0.0687	0.0004	0.0003	0.0004	0.0007
BOSTON	0.4424	0.4137	0.0871	0.4637	0.3198	0.5448	0.8900
BRAINTREE	0.0097	0.0131	0.0015	0.0149	0.0420	0.0000	0.0000
BROOKLINE	0.0712	0.0325	0.0027	0.0370	0.0000	0.1372	0.2242
BURLINGTON	0.0074	0.0005	0.0024	0.0002	0.0001	0.0002	0.0003
CAMBRIDGE	0.0666	0.0689	0.0068	0.0785	0.1848	0.0486	0.0793
CANTON	0.0000	0.0084	0.0588	0.0006	0.0004	0.0006	0.0010
CHELSEA	0.0142	0.0053	0.0008	0.0060	0.0043	0.0056	0.0091
COHASSET	0.0000	0.0008	0.0000	0.0009	0.0006	0.0008	0.0013
CONCORD	0.0000	0.0036	0.0274	0.0000	0.0000	0.0000	0.0000
DANVERS	0.0033	0.0019	0.0134	0.0002	0.0001	0.0001	0.0002
DEDHAM	0.0043	0.0069	0.0308	0.0032	0.0023	0.0030	0.0048
DOVER	0.0000	0.0003	0.0009	0.0002	0.0001	0.0002	0.0003
DUXBURY	0.0000	0.0002	0.0007	0.0001	0.0001	0.0001	0.0002
EVERETT	0.0184	0.0172	0.0074	0.0187	0.0132	0.0173	0.0283
FRAMINGHAM	0.0000	0.0032	0.0207	0.0005	0.0004	0.0005	0.0008
HAMILTON	0.0000	0.0020	0.0147	0.0001	.0000	.0000	0.0001
HANOVER	0.0000	0.0002	0.0000	0.0002	0.0001	0.0002	0.0003
HINGHAM	0.0029	0.0049	0.0006	0.0056	0.0040	0.0052	0.0085
HOLBROOK	0.0022	0.0019	0.0006	0.0021	0.0015	0.0019	0.0032
HULL	0.0000	0.0015	0.0003	0.0017	0.0012	0.0016	0.0026
LEXINGTON	0.0042	0.0003	0.0003	0.0003	0.0002	0.0003	0.0004
LINCOLN	0.0000	0.0021	0.0154	0.0001	0.0001	0.0001	0.0002
LYNN	0.0242	0.0063	0.0076	0.0061	0.0043	0.0056	0.0092
LYNNFIELD	0.0000	0.0012	0.0045	0.0007	0.0005	0.0007	0.0011
MALDEN	0.0300	0.0326	0.0065	0.0366	0.0000	0.0000	0.0000
MANCHESTER	0.0000	0.0023	0.0176	0.0000	0.0000	0.0000	0.0000
MARBLEHEAD	0.0023	0.0039	0.0177	0.0018	0.0013	0.0017	0.0027
MARSHFIELD	0.0000	0.0001	0.0005	0.0000	0.0000	0.0000	0.0000
MEDFIELD	0.0000	0.0009	0.0070	0.0000	0.0000	0.0000	0.0000
MEDFORD	0.0410	0.0186	0.0030	0.0210	0.0000	0.0000	0.0000
MELROSE	0.0047	0.0182	0.0338	0.0158	0.0112	0.0147	0.0239
MIDDLETON	0.0000	0.0001	0.0009	0.0000	0.0000	0.0000	0.0000
MILLIS	0.0000	0.0005	0.0037	0.0001	.0000	0.0001	0.0001
MILTON	0.0082	0.0151	0.0014	0.0172	0.0000	0.0639	0.1044
NAHANT	0.0015	0.0007	0.0007	0.0007	0.0005	0.0006	0.0010
NATICK	0.0000	0.0033	0.0215	0.0005	0.0003	0.0004	0.0007
NEEDHAM	0.0013	0.0010	0.0023	0.0008	0.0006	0.0008	0.0013
NEWTON	0.0243	0.0152	0.0164	0.0150	0.0000	0.0556	0.0909
NORFOLK	0.0000	0.0011	0.0085	0.0000	0.0000	0.0000	0.0000
NORTH READIN	0.0000	0.0012	0.0073	0.0002	0.0002	0.0002	0.0004
NORWELL	0.0000	0.0001	0.0000	0.0002	0.0001	0.0002	0.0003

COMMUNITY	LOCAL	EXPRESS	COMRAIL	RAPID T	RED L	GREEN L	BLUE L
NORWOOD	0.0034	0.0093	0.0620	0.0012	0.0008	0.0011	0.0018
PEABODY	0.0000	0.0024	0.0113	0.0010	0.0007	0.0009	0.0015
PEMBROKE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
QUINCY	0.0336	0.0739	0.0066	0.0843	0.2382	0.0000	0.0000
RANDOLPH	0.0053	0.0044	0.0020	0.0048	0.0034	0.0044	0.0072
READING	0.0012	0.0074	0.0527	0.0005	0.0003	0.0004	0.0007
REVERE	0.0266	0.0298	0.0000	0.0343	0.0000	0.0000	0.0000
ROCKLAND	0.0000	0.0001	0.0000	0.0001	0.0001	0.0001	0.0002
SALEM	0.0045	0.0042	0.0268	0.0007	0.0005	0.0007	0.0011
SAUGUS	0.0061	0.0021	0.0013	0.0022	0.0015	0.0020	0.0033
SCITUATE	0.0000	0.0007	0.0004	0.0007	0.0005	0.0007	0.0011
SHARON	0.0000	0.0065	0.0468	0.0003	0.0002	0.0003	0.0005
SHERBORN	0.0000	0.0005	0.0036	0.0000	0.0000	0.0000	0.0000
SOMERVILLE	0.0447	0.0317	0.0059	0.0357	0.1009	0.0000	0.0000
STONEHAM	0.0000	0.0031	0.0076	0.0024	0.0017	0.0023	0.0037
SUDBURY	0.0000	0.0006	0.0041	0.0001	.0000	0.0001	0.0001
SWAMPSCOTT	0.0026	0.0041	0.0141	0.0025	0.0018	0.0023	0.0038
TOPSFIELD	0.0000	0.0001	0.0004	0.0001	0.0001	0.0001	0.0001
WAKEFIELD	0.0042	0.0070	0.0386	0.0022	0.0016	0.0020	0.0033
WALPOLE	0.0007	0.0038	0.0280	0.0001	0.0001	0.0001	0.0002
WALTHAM	0.0094	0.0021	0.0065	0.0015	0.0010	0.0014	0.0022
WATERTOWN	0.0163	0.0069	0.0010	0.0078	0.0055	0.0073	0.0119
WAYLAND	0.0000	0.0002	0.0015	0.0000	0.0000	0.0000	0.0000
WELLESLEY	0.0000	0.0080	0.0500	0.0016	0.0011	0.0015	0.0024
WENHAM	0.0000	0.0008	0.0060	0.0000	0.0000	0.0000	0.0000
WESTON	0.0000	0.0015	0.0073	0.0006	0.0004	0.0005	0.0009
WESTWOOD	0.0011	0.0030	0.0161	0.0010	0.0007	0.0009	0.0014
WEYMOUTH	0.0077	0.0137	0.0021	0.0154	0.0109	0.0143	0.0234
WILMINGTON	0.0000	0.0017	0.0112	0.0002	0.0002	0.0002	0.0004
WINCHESTER	0.0019	0.0069	0.0404	0.0017	0.0012	0.0016	0.0026
WINTHROP	0.0000	0.0223	0.0004	0.0256	0.0181	0.0238	0.0388
WOBURN	0.0047	0.0025	0.0114	0.0012	0.0008	0.0011	0.0017

Table B.3
Level 2 Accessibility Shares

COMMUNITY	LOCAL	EXPRESS	COMRAIL	RAPID T	RED L	GREEN L	BLUE L
ARLINGTON	0.0284	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ASHLAND	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
BEDFORD	0.0029	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
BELMONT	0.0130	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
BEVERLY	0.0016	0.0316	0.0602	0.0000	0.0000	0.0000	0.0000
BOSTON	0.3974	0.3165	0.1084	0.5467	0.4762	0.4333	0.7273
BRAINTREE	0.0126	0.0190	0.0241	0.0133	0.0476	0.0000	0.0000
BROOKLINE	0.0432	0.0316	0.0000	0.0667	0.0000	0.1667	0.0000
BURLINGTON	0.0079	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CAMBRIDGE	0.0685	0.0443	0.0120	0.0800	0.2381	0.0333	0.0000
CANTON	0.0000	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
CHELSEA	0.0131	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
COHASSET	0.0000	0.0190	0.0361	0.0000	0.0000	0.0000	0.0000
CONCORD	0.0000	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
DANVERS	0.0031	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DEDHAM	0.0051	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
DOVER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DUXBURY	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
EVERETT	0.0162	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FRAMINGHAM	0.0000	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
HAMILTON	0.0000	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
HANOVER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HINGHAM	0.0049	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
HOLBROOK	0.0031	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
HULL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LEXINGTON	0.0078	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LINCOLN	0.0000	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
LYNN	0.0261	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
LYNNFIELD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MALDEN	0.0270	0.0127	0.0000	0.0267	0.0000	0.0000	0.0000
MANCHESTER	0.0000	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
MARBLEHEAD	0.0038	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MARSHFIELD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MEDFIELD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MEDFORD	0.0383	0.0127	0.0120	0.0133	0.0000	0.0000	0.0000
MELROSE	0.0049	0.0190	0.0361	0.0000	0.0000	0.0000	0.0000
MIDDLETON	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MILLIS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MILTON	0.0096	0.0253	0.0000	0.0533	0.0000	0.1333	0.0000
NAHANT	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NATICK	0.0000	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
NEEDHAM	0.0014	0.0253	0.0482	0.0000	0.0000	0.0000	0.0000
NEWTON	0.0508	0.0633	0.0361	0.0933	0.0000	0.2333	0.0000
NORFOLK	0.0000	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
NORTH READIN	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NORWELL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

COMMUNITY	LOCAL	EXPRESS	COMRAIL	RAPID T	RED L	GREEN L	BLUE L
NORWOOD	0.0042	0.0190	0.0361	0.0000	0.0000	0.0000	0.0000
PEABODY	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PEMBROKE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
QUINCY	0.0370	0.0253	0.0000	0.0533	0.1905	0.0000	0.0000
RANDOLPH	0.0070	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
READING	0.0008	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
REVERE	0.0340	0.0190	0.0000	0.0400	0.0000	0.0000	0.2727
ROCKLAND	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SALEM	0.0074	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
SAUGUS	0.0093	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SCITUATE	0.0000	0.0253	0.0482	0.0000	0.0000	0.0000	0.0000
SHARON	0.0000	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
SHERBORN	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SOMERVILLE	0.0397	0.0063	0.0000	0.0133	0.0476	0.0000	0.0000
STONEHAM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SUDBURY	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMPSCOTT	0.0044	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000
TOPSFIELD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WAKEFIELD	0.0034	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
WALPOLE	0.0009	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
WALTHAM	0.0149	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
WATERTOWN	0.0221	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WAYLAND	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WELLESLEY	0.0000	0.0190	0.0361	0.0000	0.0000	0.0000	0.0000
WENHAM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WESTON	0.0000	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
WESTWOOD	0.0013	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
WEYMOUTH	0.0104	0.0253	0.0482	0.0000	0.0000	0.0000	0.0000
WILMINGTON	0.0000	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
WINCHESTER	0.0031	0.0127	0.0241	0.0000	0.0000	0.0000	0.0000
WINTHROP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WOBURN	0.0082	0.0063	0.0120	0.0000	0.0000	0.0000	0.0000

Communities with post 1973 Express Stations:

BRAINTREE
CAMBRIDGE
MALDEN
MEDFORD
NATICK
QUINCY
SOMERVILLE
WILMINGTON
WOBURN

Inner 14 Communities:

ARLINGTON
BELMONT
BOSTON
BROOKLINE
CAMBRIDGE
CHELSEA
EVERETT
MALDEN
MEDFORD
MILTON
NEWTON
REVERE
SOMERVILLE
WATERTOWN

"Non Served" Communities:

ASHLAND
COHASSET
DOVER
DUXBURY
HANOVER
HULL
LYNNFIELD
MARSHFIELD
MEDFIELD
MIDDLETON
MILLIS
NORTH READING
NORWELL
PEABODY
PEMBROKE
ROCKLAND
SCITUATE
SHERBORN
STONEHAM
SUDBURY
TOPSFIELD
WAYLAND
WENHAM

APPENDIX C

GENERAL LAWS OF MASSACHUSETTS

ANNOTATED

CHAPTER 161A

Massachusetts Bay Transportation Authority

SEC.

§ 1. Definitions.

Wherever used in this chapter, unless the context otherwise requires, the following words or terms shall have the following meanings:—

"Authority", the Massachusetts Bay Transportation Authority created by section two of this chapter.

"Secretary,", the secretary of the executive office of transportation and construction..

"Department,", the executive office of transportation and construction.

"Commuters", all persons whose residence is in one of the fourteen cities or towns or one of the sixty-four cities or towns and whose place of work is in a city or town other than the city or town of residence, regardless of the means of transport of such persons to and from their places of work.

"Net cost of service", the difference between *(a)* all income received by the authority, including but not limited to revenues and receipts from operations, advertising, parking, sale of capital assets in the ordinary course of business, and gifts and grants for current purposes, and *(b)* all current expenses incurred by the authority, including but not limited to expenses for operations, wages, contracts for service by others, maintenance, debt service (including any debts, liabilities and obligations assumed under the provisions of law and including any applicable sinking fund requirements), taxes and rentals, and all other expenses which the authority determines not to capitalize, when such expenses exceed such income. Expenditures from the proceeds of bonds or bond anticipation notes shall not be included in current expenses.

"Net saving", any excess of the income items included in the definition of the net cost of service over the expense items included in that computation.

"Equipment", all rolling stock, and other conveyances, vehicles, rails, signal and control systems, lighting and power distribution systems, fences, station equipment, fare collection equipment, incidental apparatus and other tangible personal property, whether or not affixed to realty, required or convenient for the mass movement of persons.

"Fourteen cities and towns", the cities and towns of Arlington, Belmont, Boston, Brookline, Cambridge, Chelsea, Everett, Malden, Medford, Milton, Newton, Revere, Somerville and Watertown.

"Express service", all mass transportation service provided by or under the control of the authority, whether by ownership, lease, contract or otherwise, over rights of way with fully controlled access and restricted to the use of such service exclusively or on a shared basis with other mass transportation service, including but not

limited to rapid transit service, the Highland Branch and Mattapan high-speed services and express bus, monorail and other similar services, and such term shall also mean all commuter railroad passenger service provided by or under the control of the authority.

"Local service", all mass transportation service provided by or under the control of the authority, other than express service.

"Mass transportation facilities", all real property (including land, improvements, terminals, stations, garages, yards, shops and structures appurtenant thereto), and all easements, air rights, licenses, permits and franchises, used in connection with the mass movement of persons.

"Sixty-four cities and towns", the cities and towns of Ashland, Bedford, Beverly, Braintree, Burlington, Canton, Cohasset, Concord, Danvers, Dedham, Dover, Duxbury, Framingham, Hamilton, Hanover, Hingham, Holbrook, Hull, Lexington, Lincoln, Lynn, Lynnfield, Manchester, Marblehead, Marshfield, Medfield, Melrose, Middleton, Millis, Nahant, Natick, Needham, Norfolk, North Reading, Norwell, Norwood, Peabody, Pembroke, Quincy, Randolph, Reading, Rockland, Salem, Saugus, Scituate, Sharon, Sherborn, Stoneham, Sudbury, Swampscott, Topsfield, Wakefield, Walpole, Waltham, Wayland, Wellesley, Wenham, Weston, Westwood, Weymouth, Wilmington, Winchester, Winthrop and Woburn, and such other municipalities as may be added in accordance with section sixteen or in accordance with any special act to the area constituting the authority. (1964, 563, § 18; 1967, 87, § 1; 1969, 578, § 3; 1973, 1140, § 2.)

Editorial Note—

The 1967 amendment inserted in the definition of "Sixty-four cities and towns" the words "or in accordance with any special act".

The 1969 amendment rewrote the definition of "Commuters."

The 1973 amendment inserted the definitions of "Secretary" and "Department".

Sections 19 through 26 and 28 and 29 of Ch. 563, Acts 1964 (the act inserting this chapter), as amended, provide as follows:

SECTION 19. Section nine A of chapter thirty and chapter thirty-one of the General Laws shall not apply to any officers and employees of any authority created by chapter one hundred and sixty-one A of the General Laws, inserted by section eighteen of this act, excepting those employees of the Metropolitan Transit Authority to whom said chapter thiry-one was applicable on the effective date of this act.

Chapter thirty-two of the General Laws shall not apply to any retirement or pension system of the Massachusetts Bay Transportation Authority, but the directors shall continue payment of pensions and retirement allowances under and in accordance with the present pension plan and authorizations of the board of trustees of the Metropolitan Transit Autnority, as from time to time modified by the directors.

SECTION 20. The Metropolitan Transit Authority is hereby abolished; all mass transportation facilities, as defined in section one of chapter one hundred and sixty-one A of the General Laws, inserted by section eighteen of this act, and all other property,

§ 8. Assessment Upon Certain Cities and Towns of Portion of Net Cost of Express Service, etc.

In any year, commencing with the calendar year nineteen hundred and sixty-six, if the commonwealth shall be called upon to pay any amount on account of the net cost of express service during the previous calendar year, whether provided by ownership, lease, contract or otherwise, seventy-five per cent of such net cost of service of such previous calendar year shall be assessed upon all cities and towns comprising the authority's territory in the proportion which the number of commuters in each said city or town bears to the total number of commuters in all of said cities or towns, but in no event shall the city of Boston's share of such assessment be less than thirty per cent of such seventy-five per cent assessment of the net cost of service; provided, however, that there shall not be assessed under this paragraph that part of the net cost of service which represents the debt service on any obligation of the Metropolitan Transit Authority issued for express service purposes or any obligation of the Massachusetts Bay Transportation Authority issued to refinance the same. The number of commuters shall be determined in accordance with the latest decennial census made by the United States Department of Commerce. If said census shall not provide the necessary data for determining the number of commuters, the authority shall determine the number of commuters by some accurate and otherwise appropriate method. Twenty-five per cent of such net cost of service of such previous calendar year shall be assessed upon those cities and towns of the authority which had one or more express service stations as of the first day of July of such previous calendar year. Such assessments shall be in the proportion which the number of riders boarding at all express service stations in such city or town bears to the number of riders boarding at all express service stations in the area constituting the authority. The number of riders shall be determined by a rider count taken during the year nineteen hundred and sixty-five. Subsequent rider counts shall be made from time to time by the authority so as to maintain as much accuracy as possible with respect to changes in such service and in no event less frequently than every two years.

If the commonwealth shall be called upon to pay, otherwise than under section twenty-eight, any amount on account of that part of the net cost of service which represents the debt service of any obligation of the Metropolitan Transit Authority issued for express service purposes or any obligation of the Massachusetts Bay Transportation Authority issued to refinance the same, the cost of such debt service shall be assessed upon the fourteen cities and towns in proportion to the assessment of each such city or town in the same year under the provisions of the foregoing paragraph.

The aggregate amount to be assessed under this section in any year shall, to the extent of such debt service, be deemed to represent pro rata the debt service referred to in the foregoing paragraph and other debt service of the authority for express purposes.

For the purposes of this section riders boarding at any express service station which is opened after July first, nineteen hundred and seventy-three and which is in addition to, and not in replacement of, any station or stations existing on said date shall not be included for purposes of any count taken for purposes of the twenty-five per cent assessment of net cost of service. (1964, 563, § 18; 1969, 897; 1973, 1140, § 13; 1974, 825, § 8.)

Editorial Note—

The 1969 amendment inserted after the word "towns" in the ninth line the words "but in no event shall the city of Boston's share be less than thirty per cent of such seventy-five per cent assessment of the net cost of service."

The 1973 amendment added a paragraph providing that riders boarding at an express service station opened after July 1, 1973, not be counted for purposes of the 25 per cent assessment of net cost of service.

The 1974 amendment affected the fourth paragraph, rewriting the clause referring to the opening of the service station to make it an additional station or stations and not a replacement on the stated date.

Acts 1967, Ch. 87, which by § 1 thereof amends § 1 of GL c. 161A, provides in § 2 as follows:

SECTION 2. The town of Maynard, having become a member of the Massachusetts Bay Transportation Authority on the first day of January, nineteen hundred and sixty-seven, as provided by chapter four hundred and thirty-three of the acts of nineteen hundred and sixty-six, shall share in the assessments made under sections eight through twelve of chapter one hundred and sixty-one A of the General Laws on account of the fiscal period from September first, nineteen hundred and sixty-six through September thirtieth, nineteen hundred and sixty-seven and on account of fiscal periods and calendar years thereafter during which it continues to be included in the authority; provided that for the fiscal period September first, nineteen hundred and sixty-six through September thirtieth, nineteen hundred and sixty-seven and on account of fiscal periods and calendar years thereafter during which it continues to be included in the authority; provided that for the fiscal period September first, nineteen hundred and sixty-six through September thirtieth, nineteen hundred and sixty-seven, nine thirteenths of the number of commuters in the town of Maynard shall be used in computing said town's share of the net cost of express service under section eight of said chapter one hundred and sixty-one A, and nine thirteenths of the population of said town and the net loss attributable to all routes of local service in said town during the period January first through September thirtieth, nineteen hundred and sixty-seven shall be used in computing said town's share of the net cost of local service under section eleven of said chapter one hundred and sixty-one A.

CASE NOTES

Provisions of chapter for apportionment of costs upon municipalities are reasonable and valid.—Massachusetts Bay Transp. Authority v Boston Safe Deposit & Trust Co. 348 Mass 538, 205 NE2d 346.

§ 8A. Assessment of Cities and Towns for Net Cost of Service Provided Until July 31, 1968, etc.; Determination of Net Cost, etc.

Notwithstanding any other provisions of this chapter, that part of the net cost of service of the current and of the next fiscal period of the authority which is attributable to service provided no later than July thirty-first, nineteen hundred and sixty-eight, under agreements with railroads to provide passenger service to and from Boston, shall be apportioned as follows:

Fifty per cent thereof shall be assessed upon all cities and towns comprising the authority's territory in the proportion which the number of commuters in each said city or town bears to the total

number of commuters in all of said cities or towns. The number of commuters shall be determined in accordance with the latest decennial census made by the United States Department of Commerce. If said census does not provide the necessary data for determining the number of commuters, the authority shall determine the number of commuters by some accurate and otherwise appropriate method.

The remaining fifty per cent shall be assessed upon the cities and towns of the authority which had one or more railroad stations operated under such agreements as of the first day of the seventh month of the fiscal period in which such cost was incurred. Such assessments shall be in the proportion which the number of riders boarding at all such stations in such city or town bears to the number of riders boarding at all such stations in the area constituting the authority; provided, however, that the number of riders boarding at the North Station, the South Station, and the Back Bay Station in the city of Boston shall not be included for the purpose of determining such assessments. The number of riders shall be determined by a rider count taken during the year nineteen hundred and sixty-seven.

For the purposes of this section, the net cost of service of each fiscal period shall be attributed to such railroad service to the extent of the net cost of such railroad service to the authority during such period, and the net cost of express service to be assessed under section eight shall be reduced accordingly. To the extent paid or reimbursed under section twenty-eight or financed by the issue of bonds, the cost to the authority of agreements with railroads to provide passenger service shall be excluded from the net cost of such railroad service to the authority and from the net cost of service of the authority for the purpose of computing assessments, but the debt service on such bonds shall be included in the net cost of express service to be assessed under section eight.

The cost to the authority of agreements with railroads to provide passenger service shall be deemed a current expense for the purposes of paragraph *(i)* of section five to the extent that such cost is not to be financed by the issue of bonds and not to be met by assistance under section twenty-eight. (1967, 24, § 1; 1968, 445, § 1.)

Editorial Note—

The 1968 amendment changed the terminal date for providing service from June 30, 1968 to July 31, 1968.

§ 9. Assessment upon Fourteen Cities and Towns of Net Cost of Local Service During 1966–1975.

In any year commencing with the calendar year nineteen hundred

and sixty-six and ending with the calendar year nineteen hundred and seventy-five, if the commonwealth shall be called upon to pay any amount on account of the net cost of local service provided in the fourteen cities and towns during the previous calendar year, whether provided by ownership, lease, contract or otherwise, such cities and towns shall be assessed for such net cost of service on the basis of a combination of two percentages, one, hereinafter called "A", based upon the prior method of assessment, and the other, hereinafter called "B", based upon the proportion which the net loss attributable to all routes of such service in each such city or town bears to the net loss attributable to all such routes in all such cities and towns, as follows:

Calendar Year During Which Net Cost of Local Service Occurs.	*"A" Percentage of Assessment Based Upon Prior Method of Assessment.*	*"B" Percentage of Assessment Based Upon Loss Attributable to Routes.*
1965	95%	5%
1966	90%	10%
1967	85%	15%
1968	80%	20%
1969	75%	25%
1970	70%	30%
1971	65%	35%
1972	60%	40%
1973	55%	45%
1974	50%	50%

The loss attributable to each such route in each such city or town shall be determined by the authority in accordance with sound accounting practice on the basis of the difference between the revenues from such route in such city or town and the cost of providing such route therein. (1964, 563, § 18.)

CASE NOTES

Provisions of chapter for apportionment of costs upon municipalities are reasonable and valid.—Massachusetts Bay Transp. Authority v Boston Safe Deposit & Trust Co. 348 Mass 538, 205 NE2d 346.

§ 10. Assessment upon Fourteen Cities and Towns of Net Cost of Local Service Commencing with 1976.

In any year commencing with the calendar year nineteen hundred and seventy-six, if the commonwealth shall be called upon to pay any amount on account of the net cost of local service provided in the fourteen cities and towns for the previous calendar year, whether provided by ownership, lease, contract or otherwise, fifty per cent of such net cost of service shall be assessed upon such cities and towns in the proportion which the population of each said city or town bears to the total population of all such cities or towns, and fifty per cent of such net cost of service shall be assessed upon such cities and towns in the proportion which the net loss attributable to all routes of such service in each such city or town bears to the net loss attributable to all such routes in all such cities and towns. Population shall mean population as determined by the last preceding national census. The loss attributable to each such route in each such city or town shall be determined in the same manner as provided in section nine. (1964, 563, § 18.)

CASE NOTES

Provisions of chapter as to apportionment of costs upon municipalities are reasonable and valid.—Massachusetts Bay Transp. Authority v Boston Safe Deposit & Trust Co. 348 Mass 538, 205 NE2d 346.

§ 11. Assessment upon Sixty-four Cities and Towns of Net Cost of Local Service.

In any year commencing with the calendar year nineteen hundred and sixty-six, if the commonwealth shall be called upon to pay any amount on account of the net cost of local service for the previous calendar year provided in the sixty-four cities or towns, whether provided by ownership, lease, contract or otherwise, fifty per cent of such cost of service shall be assessed upon such cities and towns in the proportion which the population of each said city or town bears to the total population of all such cities or towns, and fifty per cent of such net cost of service shall be assessed upon any such city and town in the proportion which the net loss attributable to all routes of such service in such city or town bears to the net loss attributable to all such routes in all such cities and towns. Population shall mean population as determined by the last preceding national census.

The loss attributable to each such route in each such city or town shall be determined in the same manner as provided in section nine. (1964, 563, § 18.)

CASE NOTES

Provisions of chapter for apportionment of costs upon municipalities are reasonable and valid.—Massachusetts Bay Transp. Authority v Boston Safe Deposit & Trust Co. 348 Mass 538, 205 NE2d 346.

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